

New  
Development  
Bank

INDEPENDENT EVALUATION OFFICE

People's Republic of China  
LUOYANG  
METRO PROJECT

# PROJECT PERFORMANCE EVALUATION

FULL DOCUMENT

DECEMBER 2023

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# PREFACE

This report presents the findings of the project evaluation undertaken by the Independent Evaluation Office (IEO) of the New Development Bank (NDB), of the Luoyang Metro project in the Henan Province in the People's Republic of China. The Luoyang Metro project is the first project to be evaluated by the IEO in the People's Republic of China.

The Luoyang Metro project established the first metro line in Luoyang City in the Henan Province. Recognising the urgent need to create a sustainable integrated urban transport system in Luoyang, the provincial Government developed a four-phase strategy. The first phase of this plan included Metro Line 1.

The city has a rich historical and cultural heritage and has been the capital of 13 dynasties. It is a rapidly growing metropolis with sites that attract a large number of tourists every year. Luoyang meets the criteria established by the Government for prioritising its urban transport system due to its population size, economic development, and fiscal profile.


The project was expected to significantly improve Luoyang's infrastructure and connectivity, positively impacting the city's economic growth, productivity, and the environment.

The NDB Board of Directors approved the loan for the project on August 16, 2018, for NDB financing of USD 300 million, representing 10.8% of the project's total cost, estimated at USD 2,775.7 million. The proceeds from the NDB loan were to be used to finance the purchase and installation of all equipment. The NDB loan was expected to be disbursed over a five-year period from 2018 to 2022.

Overall, the independent evaluation found that the project was fully aligned with the policies and strategies of the Government of China for the expansion of green and sustainable transport facilities. NDB funds were utilised effectively for planned project activities and achieved the main objective of a modern and efficient transport system for the city, that would facilitate economic growth and development. The project was completed before time, incorporated notable innovative and energy-efficient aspects, and was implemented with due consideration of social and environmental safeguards. The evaluation found that, while the project cannot currently sustain itself through the revenues it generates, there is a strong government commitment to subsidise the operations as long as required.

The evaluation found that NDB relied on country systems that are well developed in China, the strong regulatory systems in place, as well as the strong technical capacity of the implementing agency. While the NDB operations staff provided flexibility and timely support in processing loan withdrawals and reimbursement applications, NDB could have invested more time in documenting and sharing lessons and knowledge from this successful operation.

I appreciate the constructive NDB Management Response to this evaluation, included in the report. I trust this report will be helpful to readers seeking to understand the anatomy of successful projects and the unique context of countries like China, which enable the successful implementation of NDB investments.

  
*Director General*  
*Independent Evaluation Office*



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# ACKNOWLEDGEMENTS

The Independent Evaluation Office of the New Development Bank would like to express its gratitude to all those who have contributed to this evaluation. Specifically, IEO is grateful to the Government of the People's Republic of China, including the Ministry of Finance, the National Development and Reform Commission, the Henan Provincial Government, the Luoyang Rail Transportation Co. Ltd., also known as Luoyang Metro Group Company, the Luoyang Municipal Bureau of Finance, the Luoyang Development and Reform Commission, the Bureau of Statistics of Luoyang, the China Association of Metros. IEO is also grateful to the passengers and resettled households who agreed to be interviewed during the evaluation process.

IEO would like to thank the NDB Board of Directors for its support and broader guidance to ensure the appropriate customisation of the evaluation to the specific context of NDB. A special thanks is due to the NDB management and operations staff and other colleagues for their openness in sharing critical reports, data, and insights.

Moreover, IEO would like to express appreciation to the Asia-Pacific Finance and Development Institute in Shanghai for peer-review of the draft report. Their comments have been included in the final report.

This evaluation was conducted under the overall supervision and direction of Mr. Ashwani K. Muthoo, Director General of IEO. He was ably supported by Mr. Xiaoxin Chen, Senior Transport Specialist; Ms. Maliha Hamid Hussein, Senior Development and Evaluation Specialist; Ms. Jaqueline Rabelo Souza, IEO Evaluation Communication and Outreach Expert; and Mr. Jinghong Zhang, IEO Evaluation Research Analyst.

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# CURRENCY UNITS AND EQUIVALENTS

Chinese Yuan = CNY  
United States Dollar = USD

USD 1 = CNY 6.53  
(As per the Project Document to the Board on September 13, 2017)  
USD 1 = CNY 6.45  
(On Project Completion on March 28, 2021)

# ABBREVIATIONS AND ACRONYMS

ATTS	Average Travel Time Savings
BoD	Board of Directors
DMF	Design and Monitoring Framework
ENPV	Economic Net Present Value
IEO	Independent Evaluation Office
LML1	Luoyang Metro Line 1
LRTC	Luoyang Rail Transit Corporation
MTR	Mid-Term Review
M&E	Monitoring and Evaluation
NDB	New Development Bank
O&M	Operation and Maintenance
PCR	Project Completion Report
PFI	Passenger Flow Intensity
PIA	Project Implementation Agency

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# EXECUTIVE SUMMARY

## A. Background and Context

The Luoyang Metro project, supported by a sovereign loan from the New Development Bank (NDB), is the first project evaluated by the Independent Evaluation Office (IEO) in the People's Republic of China.

The project was designed to launch the first metro line in Luoyang City in the Henan Province. The provincial Government recognised the urgent need to create a sustainable and integrated urban transport system in Luoyang and developed a four-phase strategy. Metro Line 1 is part of the first phase of this plan.

As a thousand-year-old ancient city, Luoyang has a rich historical and cultural heritage and has been the capital of 13 Chinese dynasties. Luoyang meets the criteria established by the Government for prioritising its urban transport system due to its population size, economic development, and fiscal profile. The city is also a rapidly growing metropolis with sites that attract a large number of tourists every year.

## B. Project Design

The project was designed to construct a total length of about 22.34 km and 18 underground stations connected by tunnels and two above-ground depots for maintenance at the two ends of the line. The length of the metro line was enhanced, and another station was added subsequently to increase the system's efficiency.

On August 16, 2018, the NDB Board of Directors (BoD) approved the loan for the project, which involves NDB financing of USD 300 million, representing 10.8% of the total cost of the Luoyang Metro Line 1 (LML1), estimated at USD 2,775.7 million. The co-financers included commercial banks (USD 1,311 million) and funding from the People's Government of Luoyang (USD 1,164 million).

The NDB loan proceeds were to finance the purchase and installation of equipment for Line 1 under Project Component 2. The procurement of goods, works, and services to be funded by the NDB loan for the project was mandated to comply with the Chinese country systems and NDB's procurement policy.

The NDB loan was expected to be disbursed over a five-year period from 2018 to 2022. The loan proceeds were on-lent to the People's Government of Henan Province for financing the project. The project implementation was the overall responsibility of the Luoyang Rail Transportation Co. Ltd. (LRTC), also known as Luoyang Metro Group Company, assigned as the Project Implementation Agency (PIA).

The project was expected to improve Luoyang's infrastructure and connectivity, positively impacting the city's economic growth, productivity, and the environment. Travel conditions were expected to improve with an alternative and more time-efficient way to travel. Road congestion was expected to ease, and emissions were also projected to be reduced.

## C. Evaluation Methodology and Process

The methodology for this evaluation entailed the use of internationally recognised evaluation criteria adopted by the Evaluation Cooperation Group of the Multilateral Development Banks but duly tailored to the NDB context. The criteria that provided the framework for assessing project performance included the following: relevance, effectiveness, efficiency, impact, and sustainability. In addition, IEO assessed the performance of NDB and borrower, respectively.

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The evaluation used mixed methods for data collection and analysis, including a review of secondary data, site visits, and interviews with key implementing agencies, especially the LRTC, customers, resettled households, employees, collaborating institutions, NDB staff, and others. The IEO evaluation team met more than 200 people representing various stakeholders, implementing partners at various tiers of government, as well as private sector and research and academic institutions involved in the design and implementation of the project.

The IEO evaluation team visited the Luoyang Metro project and its main facilities, such as the control room, the air-conditioning room in one of the subway stations, the maintenance depot, the training facilities, and the Metro Line 1 as well as the transfer station between Line 1 and the recently completed Line 2. This gave IEO the opportunity to assess first-hand the infrastructure and systems put in place.

The draft evaluation approach paper and the evaluation report were shared with NDB management and the borrower for comments. The comments have been included in the report. A final stakeholders' workshop is planned in Beijing in January 2024 to discuss the evaluation results and lessons learned.

## D. Evaluation Findings: Project Performance

### **Overall Project Achievement:** *Successful.*

Overall, the project has been rated as successful as it was completed before the original completion date, incorporated notable innovative and energy-efficient aspects, and was implemented with due consideration to social and environmental safeguards. LML1 has received 15 awards for its innovation and technical aspects at the national level. A high degree of customer satisfaction has been assessed through both third-party surveys and direct interviews.

The completed length of the metro line exceeded the plans and is 25.342 km, with 19 stations and two underground facilities for train servicing and maintenance at either end. The project entailed not only the physical construction of the underground tunnels and subways in a heritage site in a congested part of the city but also putting in place an elaborate institutional infrastructure, which now employs 2,613 regular staff in LRTC and provides many other employment opportunities to handle each aspect of the operations, including safety, security, ticketing, maintenance, and repair of the system. The project also took an innovative approach to developing digital applications for use by customers and back-end support. There are, however, some aspects of the project that could have been given greater attention, such as monitoring and evaluation (M&E), knowledge management, and supervision.

### **Relevance:** *Successful.*

The project is fully aligned with the policies and strategies of the Government of China and NDB, as well as the needs of citizens. The project has made a major contribution to expanding the city's green and sustainable transport facilities. The project's development objectives were consistent with the Luoyang Master Urban Plan 2011-2020, which was approved by the State Council, demonstrating high alignment with government priorities. The project design is also in line with the NDB General Strategy 2017-2021, as sustainable infrastructure has been an NDB priority due to its vital importance to economic growth and high demand in BRICS countries and other emerging markets and developing countries. However, the quality of the Design and Monitoring Framework (DMF) was mixed, and some project targets were over-ambitious.

### **Effectiveness:** *Successful.*

NDB funds were utilised effectively for planned project activities (i.e., the purchase and installation of equipment). The share of metro in motorised travel (SMMT) achieved 11.65% in 2022, about 194.2% of the target set at design. Similarly, the target set for the share of the metro in public transportation (SMPT) was 24.13% in 2022, which is 202.1% of the target set in the DMF. The rate of passenger level of satisfaction reached 98.17% in 2022, exceeding the target of 97% set at project appraisal. The passenger flow intensity (PFI) and average travel time savings (ATTS) have been much lower than the targets, mainly due to travel restrictions during the COVID-19 pandemic between 2020-2022 and the fact that the three-year passenger cultivation period usually required for citizens to get used to new transportation options made available has not yet been crossed.

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**Efficiency:** *Highly Successful.*

The metro project was delivered nine months before the original completion date. The disbursement rate reached 100% within the timeframe specified in the loan agreement. The period between the loan approval and effectiveness of the financing agreement was less than three months. During project implementation, 21 procurement contracts were issued between February 2019 and September 2020. The economic benefits are also positive. The re-evaluated Economic Internal Rate of Return (EIRR) is 11.11%, and Economic Net Present Value (ENPV) is CNY 8,382 million - while the Economic Internal Rate of Return is slightly less than the estimation in the project design document (original estimated Economic Internal Rate of Return at 11.15%) - the ENPV is significantly higher than that at design (original estimated ENPV 1,813 million).

**Impact:** *Highly Successful.*

Overall, the project impact is considered positive based on the results achieved within a short period after the completion, notwithstanding the negative fall-out of COVID-19-related factors. The project demonstrated innovative features in terms of its investments in energy efficiency, information technology, operation and maintenance (O&M) systems, customer orientation and satisfaction, and personnel recruitment, management, training, and retention. Although it would take time to fully assess the extent to which the development impact has been achieved, some evidence of emerging impact was observed from an economic and institutional perspective during this evaluation. Indeed, the project has achieved its main objective of a modern and efficient transport system for the city, which will facilitate economic growth and development.

**Sustainability:** *Successful.*

Various elements of sustainability, such as technical operations, financial sustainability, and environmental sustainability, were examined. The project is technically sustainable in terms of the technical capacity of the staff and compliance with technical standards of safety and environmental safeguards. The project cannot currently sustain itself through the revenues it generates, but there is a strong government commitment to subsidise the operations until required. LRTC is also developing revenue generation opportunities from the sale of retail space and advertisements and expects an increase in ticket sales from the growing tourist traffic, especially during the holiday and festival seasons.

**NDB's Performance:** *Moderately Successful.*

Given that this was among the initial projects approved by the NDB in China and considering the Bank's limited staff capacity at the time, weaknesses in project design and supervision, to some extent, constrained the achievement of even more significant project results. The frequent turnover of the designated NDB staff for this project limited the Bank's oversight and intervention during implementation (e.g., in terms of needed adjustments to DMF indicators and targets). The NDB played a minimal role in the technical aspects of project design since the project commenced implementation before the NDB financing was approved by the BoD. NDB maintained a very light-touch role in supervision and conducted only one physical supervision mission during project implementation and three missions after the project was completed in March 2021. NDB has not undertaken any mid-term review (MTR) of the project and has yet to produce the project completion report (PCR). While NDB reviewed the procurement documents routinely and focused on the environmental and social safeguards aspects, it did not provide a record of any significant technical backstopping or review of the monitoring or evaluation systems it may have undertaken.

NDB's approach reflected its high reliance on country systems in China. In the case of the project, considerable reliance was placed on the well-developed technical capacity of the country and its strong regulatory systems in place. The NDB Operations staff provided flexibility and timely support in processing loan withdrawals and reimbursement applications, which was important to ensure that project activities could be undertaken as planned. However, NDB did not invest much in documenting and sharing lessons and knowledge from this successful operation.

**Borrower Performance:** *Highly Successful.*

The performance of the various tiers of government is rated as highly successful. As this was the first

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metro line in Luoyang City, the Provincial and Municipal governments and the LRTC paid significant attention to it, and concerned government departments actively cooperated with the project. The performance of the LRTC was particularly successful, which ensured the readiness of the project implementation (e.g., recruitment and training of staff before the project start-up, mobilising technical support from experienced cities), the on-track implementation, and even early completion of project activities, and compliance with policies to ensure safety and quality. The key challenges, such as land acquisition and demolition, municipal pipeline relocation and reconstruction, and connection with utility services such as water and electricity, were facilitated in a well-coordinated and efficient manner. The Henan Provincial Finance Department managed the designated account and processed the loan withdrawals and reimbursement applications in a timely and efficient manner. The Ministry of Finance in Beijing provided the needed support and broader oversight.

## E. Conclusions

The story of the LML1 project is one of significant success. The Luoyang Metro achievements are not just confined to the construction of a state-of-the-art metro line in record time, but more importantly, it is a story of how a mammoth institutional and operational structure was created from scratch to ensure the safe and efficient management of the system. LRTC has incorporated energy efficiency and technical innovations, introduced very compassionate principles of customer care,<sup>1</sup> resettlement and compensation of construction workers, and spearheaded the development of a range of information technology products for its clients and for backend support that are now being patented.<sup>2</sup>

The project's success owes much to the high degree of technical and institutional support provided by various state planning, financing, and regulatory institutions working closely with a range of public and private institutions in China. The project provides a model for implementing infrastructure projects in many respects, and highlights the importance of a supportive and coordinated ecosystem. The LML1 also showcases how effective coordination and collaboration can yield dividends and provide a showcase for wider replication.

The experience of the LML1 project demonstrates that a strong, supportive ecosystem is vital to the success of a project. The development of the metro project received the highest level of support from state institutions and is a testament to the very strong regulatory, technical capacity and quality standards that have been established and are continuously being refined in China for something as sophisticated and complex as an underground metro in a historical city with all its associated issues of protecting heritage sites, dealing with resettlement and dislocation of households and businesses. Few developing countries have such well-developed and supportive systems, and therefore, it is important in selecting projects first to determine the country's capacity for implementation.

There are, however, some areas that would have warranted more attention, such as the quality of the DMF, M&E activities, supervision processes, knowledge management, communication and outreach, and NDB staff continuity. These are equally important aspects, especially for a relatively young organisation like the NDB.

<sup>1</sup> Including being the first metro line to include facilities for nursing mothers.

<sup>2</sup> Annex 2 provides a brief listing of the information innovations.

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## F. Recommendations

### Recommendation 1

**Strengthening project evaluability.** There is a need to strengthen NDB-financed project evaluability for assessing results, generating lessons, and promoting greater impact and sustainability. Among others, this would need Project Design Reports to include an explicit theory of change, clearly and explicitly defined project objectives in a dedicated section of the report, a coherent set of indicators listed in the DMFs at different levels of the results chain, and realistic targets.

### Recommendation 2

**A sharper focus on green and climate-resilient technologies and innovations.** NDB should ensure a sharper focus on the extent to which its investments lead to the adaptation of green and climate-resilient technologies and innovations. This can be done by promoting the inclusion of these criteria in the identification and selection of projects for financing, including specific clauses and monitoring indicators in the project financing agreements, as well as terms of references of supervision missions, among others.

### Recommendation 3

**Strengthening the value additions of the Bank at project design.** In designing new projects, sufficient attention should be given to ensure the design document adequately reflects the added value that the financing provided by NDB could bring to the borrower country and the project. This would assist in maximising the impact of NDB at the country and project level and would further strengthen NDB's role not only as co-financers of development projects but, more importantly, as a multilateral development bank with internationally recognised standards and practices, particularly for social and environmental aspects.

### Recommendation 4

**Improving project implementation support and supervision.** More regular and in-depth supervision of projects should be undertaken to follow up on some of the emerging insights in a timely manner and capture the opportunities to enhance impact. NDB should pay particular attention to ensure the DMF is designed with technical inputs from the concerned sector experts. In addition, NDB should ensure that the PIA nominates a dedicated staff for M&E to generate regular and reliable data and information. MTRs should be a regular feature for all operations, and the Bank should ensure more staff continuity during implementation.

### Recommendation 5

**Developing knowledge products based on projects to facilitate scaling up.** By consolidating experiences and good practices generated from the projects, IEO recommends that NDB prepare knowledge products to record and showcase the successful experience of NDB-financed projects. The knowledge products should be disseminated to a wider audience, including governments, Multilateral Development Banks, and other development partners in the international development community, to share successful experiences of the projects being designed and implemented in the unique context of NDB. This would be particularly useful for BRICS and other emerging markets and developing countries to learn, especially in the design and implementation of similar projects in the country. In order to properly operationalise this recommendation, design reports should include dedicated provisions for knowledge management products and dissemination.

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# 摘要

## A. 项目概况

洛阳地铁项目由金砖国家新开发银行（下称“新开发银行”）提供主权贷款支持。洛阳地铁项目评价是新开发银行独立评价局在中国开展的首个独立项目评价。

该项目规划建设河南省洛阳市的首条地铁线路。基于对洛阳建设一体化和可持续的城市交通系统的迫切需要，河南省政府制定了四个阶段的战略。其中，洛阳地铁1号线建设属于该计划的第一阶段。

作为十三朝千年古都，洛阳承载了丰富的历史文化遗产，见证了中国数千年的历史变迁。从人口规模、经济发展情况和财政状况来看，洛阳属于河南省政府的城市群都市圈交通体系优先发展区域。此外，洛阳也是一个快速发展中的城市，名胜古迹众多，每年都有大批游客慕名而来观光游览。

## B. 项目设计

项目初期规划建设地铁线路全长22.34公里，设地下车站18座，正线地下区间为隧道，线路两端设车辆段、停车场各一处，项目设计后期为提高运营效率对原规划线路进行了延伸，新增设车站1座。

2018年8月16日，新开发银行董事会批准了该项目的贷款申请，同意提供为该项目建设提供3亿美元的贷款支持，约占洛阳轨道交通一号线建设总造价（估计为27.757亿美元）的10.8%。此外，还有多家商业银行参与了此次联合融资（共13.11亿美元），洛阳市人民政府也为该项目提供了约11.64亿美元的资金支持。

新开发银行的贷款资金主要用于在遵循中国相关法律法规规定和新开发银行采购政策的基础上采购及安装洛阳市地铁一号线的相关设备。

新开发银行贷款计划于项目批准后五年内（2018年至2022年）拨付完毕。该笔贷款由中央财政转贷河南省人民政府进行项目融资。洛阳市轨道交通集团有限责任公司（简称洛阳地铁）作为项目实施机构，负责该项目整体实施。

该项目旨在进一步提升洛阳市的整体流动性、可达性和城市交通连通性及基础设施建设，并对助力洛阳市经济增长，提高生产力和促进环境保护产生了积极影响。该项目的建成为乘客提供了多样化和更省时的出行方式。与此同时，该项目对缓解路面拥堵和节能减排也作出了积极贡献。

## C. 评价方法论和流程

本次独立项目评价所使用的方法论以国际公认的Evaluation Cooperation Group（由多边开发银行评价机构组成的联合组织）评价标准为基础，并根据新开发银行的特点进行相应调整。在构建评价框架以及评价项目成效时，考虑了以下几个指标：相关性、有效性、效率、影响力和可持续性。此外，独立评价局还分别就新开发银行和借款方的表现进行了评定。

项目评价采用混合方法进行数据收集和分析，包括审查二手数据、实地调查和对主要执行机构进行访谈，特别是洛阳市轨道交通集团有限责任公司管理层及员工、乘客代表、拆迁安置户、合作机构、新开发银行相关工作人员等。在此期间，独立评价局评价团队共与200多名代表进行会见，他们代表了参与项目设计和实施的各利益相关方、各级政府的实施合作单位以及参与项目设计和执行的私营部门和学术研究机构。

此外，评价团队还实地走访了洛阳地铁项目及其主要设施，如控制室、地铁站空调候车室、停保场、培训设施、轨道交通一号线正线区间以及一号线与近期竣工的二号线之间的换乘站等。这有利于独立评价局对已建成的基础设施和交通系统进行直观评价。

评价方法文件草案和评价报告已与新开发银行管理层和借款方分享，并征求其意见。相关意见已纳入最终的评价报告中。最终的知识分享研讨会计划于2024年1月在北京举行，该研讨会旨在探讨评价结果，总结分享相关经验与做法。

## D. 评价结果：项目绩效

### 项目总体成果：成功

洛阳地铁一号线项目的总体完成情况被评为“成功”。该项目不仅提前竣工，同时在创新和节能方面成效显著，并且在实际实施过程中合理适当考虑了保障社会和环境方面的需求。该项目在规划和实施过程中采用了很多创新型设计和新技术，如在地铁站内安装磁悬浮直膨通风空调系统，在保持运行的同时实现降低碳排放、减少噪音和空气污染的绿色发展目标。第三方问卷调查和直接访谈都显示，乘客总体满意度较高。

洛阳地铁一号线竣工长度为25.342公里，超出原规划长度，共设有19座车站及2处列车停保场。该项目不仅成功地在道路条件复杂和城市繁华区域及众多文物保护区建设地铁，同时在建设过程中利用创新性技术最大限度减少了施工对文物保护的影响，同时有力缓解了城市地面交通拥挤的状况。洛阳地铁项目在实施期间先后共招聘2613名正式员工，覆盖地铁运营的方方面面，如安全、安保、票务、系统维护和列车修理，创造了大量的就业机会。该项目还开发了供乘客和后端支持人员使用的数字应用程序。此外，也应注意某些领域包括《项目设计和监测框架》的质量、知识管理、监督等方面还需要更多的关注。

### 相关性：成功

该项目与中国政府以及新开发银行的相关政策和机构战略要求高度契合，也与洛阳市民期望缓解市区交通拥堵，节省出行时间的实际需求相匹配。同时，该项目的建设为拓展中国城市绿色交通和新时代可持续发展的交通设施网络做出了重大贡献。该项目的发展目标完全符合中国国务院批准的《洛阳市城市总体规划（2011-2020年）》，体现了项目与政府优先发展事项的高度一致性。项目设计也符合新开发银行的2017-2021年总体战略。可持续基础设施对于促进金砖国家和其他新兴市场及发展中国家的经济增长以及满足人民日益增长的高需求至关重要，因此一直是新开发银行的优先发展事项。不过，《项目设计和监督框架》的质量有提升的空间，最突出的表现是部分项目目标设定的高于实际。

### 有效性：成功

新开发银行资金在项目活动（例如采购和安装设备）中得到了有效的利用。据统计数据显示，2022年轨道交通占洛阳市居民机动化出行比例达11.65%，约为设计目标的194.2%。此外，2022年轨道交通占洛阳市公共交通出行比例为24.13%，达到了近期规划客流量目标的202.1%。2022年洛阳地铁一号线乘客满意度为98.17%，超出了项目设定的97%的目标。洛阳地铁客流强度和节省出行时长远低于预期目标，主要原因是2020-2022年间，为防控新冠疫情，政府采取了严格的限制人员流动措施。除此之外，地铁客流培养以及市民采取地铁出行的习惯需要三年左右的培育期才能实现。

### 效率：非常成功

与原计划相比，洛阳地铁项目提前9个月竣工。在贷款协议规定的时间范围内，拨付率达到100%。贷款批准和贷款协议生效时间差距不到三个月。在该项目实施期间，2019年2月至2020年9月共签发了21份采购合同。该项目经济效益良好。重新评估的经济内部收益率为11.11%，经济净现值为83.82亿人民币，其中经济内部收益率略低于项目设计文件中的估算值（原估算结果为11.15%），但经济净现值远高于项目设计文件中的估算值（原估算结果为18.13亿人民币）。

### 影响力：非常成功

总体而言，从项目竣工后短期内取得的成果上来看，即使存在新冠疫情等相关因素的影响，洛阳地铁项目



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产生了积极影响。该项目还在能源效率、信息技术、运营和维护系统、乘客引导和满意度以及人员招聘、管理、培训和留用方面进行有特色的投资，并体现出了较强的创新性。虽然全面评价洛阳地铁项目对促进城市发展的影响力还需更多时间，但在本次评价中，独立评价局发现该项目已经在推动经济发展和完善社会基础设施方面产生新的积极影响，并且已经能够观测到部分相关实证。该项目经实现了建设高效的现代化城市群都市圈交通体系的主要目标，促进经济增长和城市发展。

#### **可持续性：非常成功**

这一评价指标考量了如技术操作、财务可持续性和环境可持续性等方面。该项目规划和施工人员均具备专业知识和技能，项目生产施工过程中严格遵守安全和环境标准，充分体现了技术可持续性。尽管项目目前暂无法通过车票收入等维持运营，但政府承诺会在其需要时提供补贴。洛阳市轨道交通集团有限责任公司同时也在利用出售零售空间和广告位实现创收，尤其是在节假日期间，游客数量激增带动了车票收入。

#### **新开发银行表现：比较成功**

洛阳地铁项目是新开发银行成立初期在中国批准的首批项目之一。考虑到当时人力资源有限，项目设计和监督都属于较薄弱环节，在一定程度上限制了项目成果的实现。负责该项目的新开发银行项目团队成员更换较频繁，使得项目团队一定程度未能充分发挥银行在项目实施期间的监督作用和引导能力（例如，在对设计和监督框架指标和目标进行及时和必要的调整方面）。新开发银行在项目设计环节技术领域发挥的作用较少，因为该项目在新开发银行融资获得董事会批准之前就已开始实施。新开发银行的监督角色较少，项目实施期间开展了一次实际考察任务，在2021年3月项目竣工后，共执行了三次考察任务。新开发银行目前尚未对项目进行中期审查，也尚未出具项目完工报告。虽然新开发银行定期审查采购文件，并重视环境和社会保障方面的内容，但其并未提供有关重要技术支持，或就监督或评价系统潜在的问题进行审查。

新开发银行的做法表明其重点依托中国国内制度体系。就该项目而言，新开发银行重点依托中国较强的技术能力及其强有力的监管制度。新开发银行业务人员在处理贷款提款和偿付申请方面具有灵活性，能够及时提供支持，这对于确保项目活动按计划取得进展十分重要。然而，新开发银行在记录、总结和分享此次成功经验和专业知识方面投入的时间和精力较少。

#### **借款方表现：非常成功**

各级政府和相关单位在洛阳地铁项目中的表现非常好。该项目规划建设洛阳市首条地铁线路，洛阳市政府和洛阳市轨道交通集团有限责任公司对此高度重视，相关政府部门也积极配合。其中，洛阳市轨道交通集团的表现尤其突出，它不仅妥善安排好了项目准备工作（例如，在项目启动前招聘和培训工作人员，动员有经验的专家提供技术支持），保证项目正常实施，甚至还实现项目提前竣工，在遵守政策要求的情况下，以高速度、高质量、高安全水平顺利交付项目成果。项目期间，土地征收和房屋拆迁、市政给水管道迁改、水电等公用服务连接等关键挑战层出不穷，各级政府和相关单位积极协调，高效合作，妥善地解决了项目施工过程中遇到的各种问题。河南省财政厅负责管理专款专项账户，保障了及时高效地处理贷款提款和偿付申请工作。中国财政部为此提供了必要的支持和广泛的监督。

## E. 结论

洛阳轨道交通一号线建设项目取得了极大的成功。它不仅在极短时间内建成了一条技术先进的高质量地铁线路，创下历史纪录，通过从零开始构建复杂庞大的基础设施和交通运输网络，确保交通体系得到安全和高效的管理。洛阳市轨道交通集团在项目建设过程中展现出充满人性化的乘客关怀<sup>1</sup>、建筑工人安置和补偿原则，有效整合能源效率和技术创新成果，并开创性地为乘客和后端支持人员开发了一系列信息技术产品，这些产品目前正在申请专利<sup>2</sup>。

洛阳地铁项目的成功离不开中国各级政府规划提供技术和制度支持、融资举措以及与公共和私营机构密切合作以及监管机构的支持。该项目在许多方面均具有借鉴意义，为未来相关领域基础设施项目树立了成功的典范，体现了多部门联动协调、合力推进的重要性。洛阳轨道交通一号线建设项目还体现了协调合作的力量，为将成功经验推广至中国所有的在建或新建地铁项目提供了一个展示平台。

同时，洛阳地铁一号线项目的建设经验充分显示出强有力的国家政府机构在项目实施过程中所发挥的关键作用。洛阳地铁项目的开发得到了政府和机构的大力支持，其成果证明中国已经建立健全强大的监管、技术开发和质量保障制度体系，可妥善应对为历史文化名城修建地铁这样复杂和精密的问题，并就如何保护文物、处理居民安置和搬迁等所有相关问题做出合理的安排和妥善的解决。极少有发展中国家像中国一样拥有如此完善的支持性制度体系。因此，新开发银行在确定所支持的项目时，应注意分析项目所在国的实施能力。

此外，项目的设计和监管质量、监督和评价活动、监督程序、知识管理、沟通和外联以及新开发银行工作人员的连续性方面值得更多关注。这些方面同样重要，特别是对于像新开发银行这样相对新的多边发展银行而言。

## F. 建议

### 建议 1:

**需加强项目的可评价性。**有必要加强新开发银行所支持项目的可评价性，以评价结果，总结经验为核心，汲取经验教训并促进更大的影响和可持续性。具体措施可包括在项目设计报告中纳入明确的变革理论，在报告的专门部分明确定义项目目标，在成果的各级设计和监督框架中指定明确的指标以及切合实际的目标。

### 建议 2:

**进一步关注绿色和适应气候变化的技术和创新。**新开发银行应更加关注其支持的项目对推动绿色发展和适应气候变化的技术和创新的影响。这一点可通过在确定和选择贷款项目时纳入这些标准来实现，包括在贷款协议中的特定条款和监督指标，为项目考察团设置参考事项等等。

### 建议 3:

**在项目设计中加强新开发银行的附加值。**在设计新项目时，应尽可能确保设计文件充分反映新开发银行贷款为资金借入国和项目带来的附加值。这有助于最大限度地发挥新开发银行在国家和项目层面的影响，并进一步加强新开发银行联合融资的积极作用。更重要的是，强化其作为多边开发银行采用国际公认标准和惯例的做法，尤其是在社会和环境方面。

### 建议 4:

**优化对项目实施过程中所提供的支持和监督。**应对项目进行更加定期和深入的监督，以便及时跟进最新动向，并利用合适机会增强项目的影响力。新开发银行项目团队应特别注意确保设计和监督框架参考相关行业专家的技术意见。此外，新开发银行应确保项目实施机构指定专门的监督和评价人员，以确保定期生成

<sup>1</sup> 包括首条配备母婴设施的地铁线。

<sup>2</sup> 附件二详列。

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真实可信的数据和信息。中期审查应作为常规流程运用在所有业务中，新开发银行须在项目实施期间确保其跟进项目进展的工作人员的连续性。

**建议 5:**

**基于项目开发知识产品，促进项目经验推广。**独立评价局建议新开发银行通过整合项目中产生的经验和良好做法，开发知识产品，以记录和展示新开发银行支持的项目的成功经验。知识产品应向更广泛的受众传播，包括政府部门、其他多边开发银行和国际社会的其他发展伙伴，以分享在新开发银行独特背景下设计和实施的项目的成功经验。这些经验对金砖国家和其他新兴市场及发展中国家十分具有借鉴意义，特别是该国在设计和实施类似项目的时候。为确保这一建议得到合理推进，项目设计报告应包括有关开发知识管理产品及其传播的专门规定。

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# NDB MANAGEMENT RESPONSE

The New Development Bank (NDB) management expresses its gratitude for the Independent Evaluation Office (IEO) evaluation's quality and timeliness and acknowledges the thorough examination conducted on the Luoyang Metro project, which included valuable inputs from the Bank's operations team. Recognising the significance of the IEO's findings, the Management wishes to affirm its dedication to fostering a constructive and collaborative relationship with the IEO. This commitment is driven by the shared goal of continued enhancement in operational practices. The following comments will delve into the Management's detailed responses to each specific recommendation outlined in the IEO report, thereby elucidating the proactive steps taken by management to address the identified areas for improvement.

## Recommendation 1

The need to strengthen project evaluability. There is a need to strengthen NDB-financed project evaluability for assessing results, generating lessons, and promoting greater impact and sustainability. Among others, this would need Project Design Reports to include an explicit theory of change, clearly and explicitly defined project objectives in a dedicated section of the report, a coherent set of indicators listed in the Design and Monitoring Frameworks (DMFs) at different levels of the results chain, and realistic targets; provisions for regular supervision during implementation; MTR conducted in all cases, once during project implementation - a provision which should be included in loan agreements; and the preparation of Project Completion Reports (PCRs) by the NDB in a timely manner.

### NDB Management Response

**NDB management acknowledges the importance of ensuring that the Bank's projects have clearly defined and measurable development objectives and that the necessary tools have already been put in place both at the appraisal and implementation stages.** Every Project Document to the Board submitted for consideration by the Board of Directors (BoD) includes a dedicated DMF section outlining project objectives and their indicators based on the theory of change approach, in line with the practice of other multilateral development banks. The process for project monitoring is also clearly defined in staff guidelines. It ensures both effective and efficient project supervision, including continuous tracking of the achievement of the DMF indicators and their recording in project performance assessment reports prepared by NDB on a periodic basis. During the implementation stage, the Bank conducts regular review missions to assess the progress and address any potential challenges faced by the project. Lessons learned from NDB projects are analysed and disseminated during the preparation of PCR based on evaluation criteria recently prepared by IEO.

## Recommendation 2

A sharper focus on green and climate-resilient technologies and innovations. NDB should ensure a sharper focus on the extent to which its investments lead to the adaptation of green and climate-resilient technologies and innovations. This can be done by promoting the inclusion of these criteria in the identification and selection of projects for financing, including specific clauses and monitoring indicators in the project financing agreements, as well as terms of reference of supervision missions, among others.

### NDB Management Response

**NDB management considers supporting green and climate-related projects as one of the key elements of NDB operations and proposed to dedicate 40% of new approvals to projects contributing to climate change mitigation and adaptation in NDB's General Strategy for 2022-2026.** In line with this initiative, NDB's regional offices have engaged in dialogue with member countries to prioritise projects or their components that contribute to the transition to lower-emission economies and help in adapting to climate change during the formulation of country project pipelines. Further, to strengthen practical mechanisms of identifying and calculating project effects related to climate finance, a special guideline is currently under preparation by the NDB Strategy, Policies, and Partnership Department.

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### Recommendation 3

Strengthening the value additions of the Bank at project design. In designing new projects, sufficient attention should be given to ensure the design document adequately reflects the added value that the financing provided by NDB could bring to the borrower country and the project. This would maximise the impact of NDB at the country and project level and would further strengthen NDB's role not only as co-financers of development projects but, more importantly, as a multilateral development bank with internationally recognised standards and practices, in particular in the areas of social and environmental aspects.

#### NDB Management Response

**NDB's support to the member countries is beyond financial terms as it aims to be of symbolic value to mobilise financial resources to overcome development challenges, provide knowledge, generate lessons, and disseminate experience in aspects of technology, environmental and social impact management, project implementation, capacity building, etc.** NDB management has directed staff to identify where NDB's value addition can be provided from the very beginning of the project cycle through engaging with project entities to improve the project design. The consideration of strengthening NDB's value addition is already embedded and will continue to be emphasised in the templates of the Project Document to the Board and PCR, as well as concept note if feasible at this stage. This enhances the project team's awareness of incorporating NDB value addition in the design and structuring stage (concept stage and appraisal stage) and then collecting and recording the evidence of NDB value addition in the PCR.

In E&S aspects, NDB undertakes environmental and social due diligence to ensure projects' compliance with NDB's Environmental and Social Standards and provides relevant requirements to clients in the form of Environmental and Social Impacts Management Plans (ESIMP). NDB's ESG department also records its value addition to projects in its periodic portfolio report.

In the procurement aspect, the NDB procurement team applies quantified procurement-related criteria to assess the project procurement readiness and project procurement risks and to propose risk mitigation measures accordingly, if required, during the whole life cycle of the project.

### Recommendation 4

Improving project implementation support and supervision. More regular and in-depth supervision of projects should be undertaken to follow up on some of the emerging insights in a timely manner and capture the opportunities to enhance impact. NDB should pay particular attention to ensure the DMF is designed with technical inputs from the concerned sector experts. In addition, NDB should ensure that the PIA nominates a dedicated staff for M&E to generate regular and reliable data and information. The Bank should ensure more staff continuity during implementation.

#### NDB Management Response

**NDB management agrees with the importance of ensuring effective project implementation support and monitoring.** To increase the efficiency of this work and enhance responsiveness to developments in project implementation, it has been decided to hand over projects at this stage from NDB headquarters to NDB regional offices with the respective increase in their staff. In cases when NDB lacks the internal capacity to design the DMF for technically complicated projects, the Bank hires sector experts as suggested by IEO. On the client's side, if there is a deficiency in the project entity's capacity in terms of M&E aspects, NDB allocates a part of its loan to finance the cost of hiring a dedicated project management consultant.

### Recommendation 5

Developing knowledge products based on projects to facilitate scaling up. By consolidating experiences and good practices generated from the projects, IEO recommends that NDB prepare knowledge products to record and showcase the successful experience of NDB-financed projects. The knowledge products should be disseminated to a wider range of audiences to share successful experiences of the projects being designed and implemented in the unique context of NDB. This would be particularly useful for BRICS and other emerging markets and developing countries to learn, especially in the

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design and implementation of similar projects. It would also contribute to strengthening NDB's visibility and brand. In order to properly operationalise this recommendation, design reports should include dedicated provisions for knowledge management activities.

### **NDB Management Response**

**The Management supports the utilisation of various platforms for sharing knowledge, lessons, and good practice and will continue to emphasise the importance of project-based knowledge exchange with development partners.** NDB management considers one of the value-additions of NDB is to serve as a platform of knowledge exchange between its member countries both at the project and institutional level.

At the project level, NDB project teams start the work on every new project by analysing similar projects financed by NDB in other countries, including technology used and practices of structuring project implementation arrangements. Based on this research, NDB project teams share suggestions with project entities on how the respective projects can be improved, with due consideration of local requirements. To this end, project-specific dedicated workshops with the participation of experts from NDB member countries can be organised, as was recently done for the Dhaka Water Supply Project. Similarly, in 2023, NDB organised presentations of the successfully implemented Putian Pinghai Bay Offshore Wind Power Project at the Climate-Smart Connectivity Infrastructure Workshop Series and NDB's Annual Meeting.

At the institutional level, NDB has started to organise sector knowledge exchange workshops; for example, one workshop is currently being prepared in South Africa to cover the electricity sector reform. NDB also publishes research reports to present its projects and the important role it plays as a development financier, such as the joint reports with Boao Forum Asia on "Sustainable Development: Asia and the World Annual Report 2023" and "Sustainable Development: Asia and the World Annual Report 2022", among others. The procurement division organises regular capacity-building activities during the project due diligence as well as implementation stages, such as the capacity-building workshop for 120 participants from Chinese project entities to enhance project implementation agencies' procurement capacities.

# I. BACKGROUND

## A. Project Context

1. The New Development Bank (NDB) Board of Directors (BoD) approved a loan of USD 300 million to the People's Republic of China for the Luoyang Metro Line 1 (LML1) Project on July 20, 2018. The total project cost was estimated at USD 2,775.7 million. NDB loan represented 10.8% of the total estimated cost of the project and was earmarked to finance the purchase and installation of equipment. The project was expected to reduce heavy traffic in highly congested urban areas and improve mobility and accessibility of urban commuters, providing a safe, reliable, and comfortable means of transport for the commuters in Luoyang city.

## B. Sectoral Context

2. To support a greener transport system and promote more inclusive development, China's 13th Five-Year Plan 2016-2020 targets rapid expansion of subway networks, including in second-tier cities, to encourage the usage of eco-friendly transportation. The plan envisions a more sustainable transport system with a priority focus on high-capacity public transit, particularly urban rail and rapid bus transit. Underground urban rail has become one of the best and most effective solutions for facilitating urban development in an eco-friendly manner. The concept of "constructing rail transit to build a city" has become the guiding principle for developing major cities in the country. Today, China has established the world's largest metro systems, having four of the top ten busiest metros in the world. In addition, 80% of the world's ongoing urban rail projects are in China.
3. Like most public infrastructure facilities, government authorities own and manage metro systems in China. The regulatory framework of metro systems involves various government authorities at the national and regional levels. At the national level, the National Development and Reform Commission is responsible for formulating plans and policies regarding metro network development. China's extensive metro development has led to increasing levels of standardisation, with the application of standard rules and regulations for urban rail throughout the country. A group of experienced companies and design firms conducts most metro development. This has led to faster, more efficient, and safer development of metros.

## C. Henan Province and the City of Luoyang

4. Henan, located in central China, is China's third most populous province, with over 94 million inhabitants.<sup>1</sup> The province has the fifth largest provincial economy in China and the largest provincial economy among inland provinces. It is regarded as the cradle of Chinese civilisation, with over 3,000 years of recorded history. The province has remained China's cultural, economic, and political centre for a very long time. The province is home to some significant heritage sites, including the ruins of the Shang Dynasty, the capital city of Yin, and the Shaolin Temple. Four of China's "Eight Great Ancient Capitals," namely Luoyang, Kaifeng, Anyang, and Zhengzhou, are also located in Henan.
5. The province has advanced in terms of economic development over the last two decades, helping create employment opportunities, increase disposable income, and increase the number of privately owned vehicles. As a result, the existing transport networks in the major cities of Henan are insufficient to meet the rapidly rising urban mobility needs. The People's Government of Henan Province drew up a plan to create metro networks in the cities of Zhengzhou and Luoyang. The metro network in the capital city of Zhengzhou was the first to be developed, and the first line was made operational in 2013. The network has now expanded to cover three lines with 61 stations.

<sup>1</sup> National Bureau of Statistics of the People's Republic of China.

6. Luoyang is situated in the western part of Henan Province, about 138 km away from Zhengzhou, the capital city of Henan. The urban population of the area was estimated to be 2.85 million. According to the age distribution of China's population in 2022, approximately 68.2% of the population comprised working-age people between 15 and 64 years of age. Retirees aged 65 years and above made up about 14.9% of the total population.<sup>2</sup> Urban Planning Authorities 2011-2020 of Luoyang suggested that in 2020, Luoyang's urban employment ratio was likely to reach 50%, with a total number of 1.37 million jobs. Most of the jobs are concentrated in a few areas, signalling a need to create additional transport networks.
7. Luoyang has been the capital city of 13 dynasties of China, has rich historical and cultural heritage sites, and attracts a large number of tourists every year. The conservation area in Luoyang is highly congested due to high population density and tourism. The historical urban structures resulted in extremely narrow roads in conservation areas. Shortage of parking space makes the traffic conditions even worse, and the situation is likely to deteriorate even further. The demographic profile of the city also shows that there are a large number of students and young workers in the city and a large number of retired people. This called for an urgent response from the urban planning authorities in the city. Urbanisation has overburdened the city's existing transport infrastructure, and challenges stemmed from inadequate connectivity of the city and limited investment in modern transport systems.
8. The People's Government of Henan Province recognised the urgent need to create a sustainable, integrated urban transport system in Luoyang. It developed a four-phase strategy to integrate the metro network in the city.<sup>3</sup> Integration of public transport systems was incorporated in the planning of the metro network. Several studies have been undertaken for the bus-rail integration to provide a seamless service to commuters. Luoyang's Five-Year Plan 2016-2020 also aimed to make the city an important transportation hub, focusing on a modern and integrated transport system.
9. The Luoyang metro system has been included in several other plans since early 2010 and has been a long-standing aspiration of the city. The Luoyang Comprehensive Traffic Plan 2010-2020 includes the four planned metro lines and elaborates how the metro will interact with the other existing and planned transport infrastructure. The Luoyang City Master Plan 2011-2020 also indicates that the four lines of urban rail totalling 100 km will contribute to the development of the urban city centre. In order to facilitate the Luoyang Rail Transit Project's planning and preliminary work, in December 2009, the Luoyang Municipal Party Committee and Government established the Preparatory Office of the Luoyang Urban Rail Transit Project. They prepared Urban Rail Transit Line Network Planning for Luoyang based on the Comprehensive Traffic Plan for Luoyang 2010-2020. On August 25, 2016, the National Development and Reform Commission formally approved the Construction Planning of Luoyang Urban Rail Transit Project Phase I 2016-2020. The plan clearly stipulates that the project shall be reviewed (approved) in strict alignment with the approved Construction Planning.
10. The Metro Line 1 was expected to assist in promoting the city's vast cultural relics since it gives convenient access to cultural tourist destinations. The North Luo District, standing at the centre of Luoyang's urban area, with more than 1.2 million residents, was to be the primary beneficiary of Line 1. The main benefit of developing the Luoyang metro was to provide a speedy and reliable mode of transport to the passengers. The NDB-financed LML1 project was designed to make Luoyang the second city in the province to develop a metro system to tackle the problems related to an overburdened transport infrastructure. Figure 1 below provides the location of the NDB-financed Metro Line 1.

<sup>2</sup> <https://www.statista.com/statistics/270163/age-distribution-in-china/>

<sup>3</sup> In the first phase, Line 1 of the network will be developed, and the development of Line 2 will closely follow. Lines 3 and 4 also are planned and will be developed in subsequent phases.



FIGURE 1

### Map of Luoyang Metro Line 1



Source: Feasibility study report provided by the Luoyang Rail Transportation Co. Ltd. (LRTC)

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## II. PROJECT BACKGROUND

### A. Project Objectives

11. The objective of the project was to provide a safe, reliable, and comfortable means of transport for the commuters in the city. The project was designed to connect the residential areas to the city centre of Luoyang and provide easy access to public services, businesses, commercial centres, and cultural sites. The project was also expected to support the economic development of Luoyang and promote the overall development goals of Luoyang City as a provincial sub-central city, promote its growth as a manufacturing base, and promote its tourism.

### B. Project Design and Components

12. The project was designed around three components, which were closely integrated and are described below. The project was piloted using an energy-saving design, mainly aiming at: (a) air conditioning ventilation system, power supply system, communication signal system, and vehicle system; (b) traction power supply system; (c) electricity system improvement; and (d) kinetic energy recovery system from trains to innovate energy-saving technology for consumption reduction.
  - **Component 1:** Construction of the LML1 (construction of stations and boring of tunnels). Component 1 was financed entirely by funds from commercial bank loans and/or Government of Luoyang contributions. It was estimated that USD 1,125.68 million would be spent on this component, accounting for 40.6% of the total project cost at appraisal.
  - **Component 2:** Equipment for the LML1 (purchase and installation of equipment such as train sets, power lines, signalling, communication, fare collection, etc.). This component was mainly financed by the NDB loan and included the purchase and installation of the equipment for the operation of Line 1. This component's initial proposed project cost was USD 675.81 million, which constituted 24.3% of the total project cost.
  - **Component 3:** Design, construction management, and technical assistance (consultancy for project documents, reports, approvals, staff and management training, and research). This component included activities such as capacity-building to ensure staff would be properly trained and qualified for the operation of Line 1 and other future lines in the city. It was estimated that USD 497.7 million from non-NDB funds would be allocated to this component, accounting for 17.9% of the total project cost.

### C. Implementation Arrangements and Support

13. **Implementation Arrangements.** At appraisal, a two-level institutional structure was proposed by the Government of Luoyang for the project's management and implementation. The overall project management and coordination responsibility was entrusted to Luoyang Urban Rail Construction Command Office an entity jointly established by concerned government agencies both at the municipal and district levels. For project execution, the Luoyang Rail Transportation Co. Ltd. (LRTC) served as the project implementation agency (PIA), which was responsible for the daily management of project preparation and implementation, including procurement, counterpart fundraising, project construction and completion acceptance, operation and maintenance (O&M), financial management, fiduciary compliance, monitoring and evaluation (M&E), resettlement, and social and environmental safeguards.
14. **Supervision Arrangements.** NDB directly supervised the project. The NDB operations department undertook four missions in September 2019, April 2021, June 2021,<sup>4</sup> and April 2022. The last mission was virtual due to travel constraints during the COVID-19 pandemic.

4 Environmental and Social Implementation Review Mission (April 21-25, 2021).

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- 15. Project Timelines.** The construction of LML1 was started at the end of June 2017. NDB fielded the project appraisal mission to Luoyang from September 8-18, 2017. The BoD approved the NDB loan to finance the project on July 20, 2018. The loan agreement was signed on August 16, 2018, and entered into force on October 15, 2018. The project was completed on March 28, 2021, nine months earlier than the original completion date (December 31, 2021). The project's closing date was originally set for August 15, 2022. At the time of the project's original completion date, at the end of December 2021, NDB loan funds had been fully disbursed.

## D. Cost and Financing

16. According to the feasibility study report of the project, the total project cost was estimated at USD 2,775.7 million at appraisal (about CNY 18,119.48 million equivalent), to which NDB contributed USD 300 million, representing 10.81% of the total cost. NDB financing was provided in the form of a Sovereign Loan with a maturity of 22 years, including a grace period of four years. The other sources of the project financing included (i) USD 1,311 million equivalent of financing from commercial banks and (ii) USD 1,164 million equivalent of financing from the local government (Government of Luoyang). The Government also committed to fund cost overruns, if any, through additional equity contributions and/or additional debt from banks/financial institutions.
17. During the subsequent engineering design phase of the project (i.e., the official project design), the total project cost was revised to CNY 18,271 million, including a contingency fee of CNY 460 million. On October 27, 2017, the Henan Provincial Development and Reform Commission approved the project's engineering design, and the PIA proceeded with the construction in accordance with the approved design. The total project financing is shown in table 1.

TABLE 1

Total project financing<sup>5</sup>

	Amount in CNY (In million)	Amount in USD (In million)	% of Total Financing
<b>Component 1: construction of Line 1</b>	<b>7,348.46</b>	<b>1,125.68</b>	<b>40.6%</b>
Station	3,629.52	555.99	20.0%
Tunnel	2,330.56	357.01	12.9%
Track	509.52	78.05	2.8%
Depot	702.47	107.61	3.9%
Operation buildings	176.40	27.02	1.0%
<b>Component 2: equipment for Line 1</b>	<b>4,411.68</b>	<b>675.81</b>	<b>24.3%</b>
Rolling stock	897.00	137.41	5.0%
Communication system	355.00	54.38	2.0%
Signal system	324.78	49.75	1.8%
Power supply	1,327.61	203.37	7.3%
Monitoring system (including environment)	226.40	34.68	1.2%
Safety/security/civil air-defence	150.53	23.06	0.8%
Ventilation/AC	218.29	33.44	1.2%
Water supply/sewerage/fire protection	131.50	20.14	0.7%
Automatic fare collection (AFC) system	185.88	28.47	1.0%
Depot equipment	305.32	46.77	1.7%
Station auxiliary equipment	289.36	44.33	1.6%
<b>Component 3: land acquisition and consultancy</b>	<b>3,244.85</b>	<b>497.07</b>	<b>17.9%</b>
Land acquisition	1,348.11	206.51	7.4%
Pre-stage work, design, survey, revisions, capacity building	1,896.75	290.56	10.5%
<b>Total baseline costs (excluding contingencies)</b>	<b>15,005.00</b>	<b>2,298.56</b>	<b>82.8%</b>
Contingencies	1,410.80	216.12	7.8%
<b>Total project costs (including contingencies)</b>	<b>16,415.80</b>	<b>2,514.67</b>	<b>90.6%</b>
Interest during construction	1,689.88	258.87	9.3%
Initial working capital	13.80	2.11	0.1%
<b>Total financing required</b>	<b>18,119.48</b>	<b>2,775.66</b>	<b>100.0%</b>

Source: LRTC (as of September 2023)

<sup>5</sup> It is noted that the Project Document presented to the BoD used the total project cost as estimated in the project feasibility study report rather than the official design approved by the Henan Provincial Development and Reform Committee.

# III. EVALUATION OBJECTIVES, METHODOLOGY, AND PROCESS

## A. Evaluation Objectives

18. This is the first evaluation undertaken by the Independent Evaluation Office (IEO) of an NDB-financed project in China. The main objectives of the evaluation were to (i) provide an independent assessment of the results and impact of the LML1 project and (ii) generate findings and recommendations for ongoing and future NDB operations in China and elsewhere.

## B. Scope

19. While NDB was responsible for only financing component 2 of the project, this evaluation focused on all key elements of the LML1 project to provide a holistic assessment of the operation. This included inter-alia, technical aspects of the project, economic and social impact (e.g., land acquisition and resettlement), human resources development, operation and management, safety and environmental aspects, financial management, and sustainability, among others.

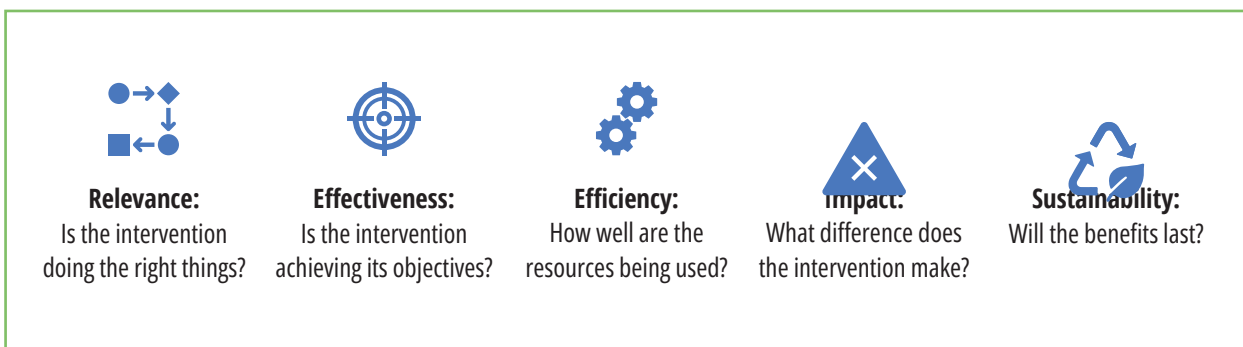
## C. Methodology, Evaluation Questions, and Rating Scale

20. The evaluation was undertaken within the overall framework of the NDB Evaluation Policy, approved by the BoD in August 2022. The evaluation used mixed methods, including both qualitative and quantitative analysis. Whilst following the internationally recognised evaluation methodologies and processes adopted by the Evaluation Cooperation Group of the Multilateral Development Banks and the United Nations Evaluation Group, IEO carefully considered NDB's unique context, mandate, and operating model in conducting its evaluation. This was particularly important to ensure the evaluation's findings and recommendations are relevant and useful for the Bank and other concerned stakeholders.

21. **Evaluation Criteria:** The evaluation used five key evaluation criteria, namely *relevance, effectiveness, efficiency, impact, and sustainability*. These criteria provided the basis for defining the evaluation questions covered in the analysis. Figure 2 below shows a summary of the evaluation criteria along with the overarching question considered under each criterion. Based on assessment and ratings assigned to each of these five criteria, IEO provided a rating to a composite evaluation criterion, *overall project achievement*. Lastly, the evaluation also assessed the performance of NDB and the borrower, respectively, as their contributions are key drivers in the delivery of the project.

FIGURE 2

### Key evaluation criteria



Source: NDB (as of September 2023)

22. The key questions that were used to assess the performance under each criterion are listed below. In addition, a complete set of questions analysed may be seen in the evaluation framework in Annex 6.

- i. **Relevance:** To what extent were project objectives aligned with the priorities of the NDB, Government, and target beneficiaries (urban commuters, including low-income group people, females, children, and other vulnerable groups), and was the design appropriate to meet the objectives defined?
- ii. **Effectiveness:** To what extent have project objectives been achieved, or likely to be achieved, at the time of the evaluation?
- iii. **Efficiency:** To what extent did the NDB intervention deliver results in an economical and timely manner?
- iv. **Impact:** To what extent has the NDB intervention generated or is likely to generate significant positive or negative, direct or indirect, intended or unintended, higher-level longer-term effects from economic, social, and institutional perspectives?
- v. **Sustainability:** To what extent are the net benefits of the project likely to continue after project completion?

23. **Rating Scale.** Based on the evidence collected and using triangulation techniques, the evaluation team assigned a rating to each of the evaluation criteria. IEO follows a six-point rating system where six is the highest score, and one is the lowest score (see table 2).

TABLE 2

Rating scale

Rating	
6	Highly Successful
5	Successful
4	Moderately Successful
3	Moderately Unsatisfactory
2	Unsatisfactory
1	Highly Unsatisfactory

Source: NDB (as of September 2023)

24. **Stakeholder Participation.** In accordance with the NDB Evaluation Policy, the main project stakeholders were involved in key stages of the evaluation process. This ensured that their perspectives were taken into account in the evaluation process. For instance, the draft evaluation approach paper and draft report were circulated to key stakeholders to collect comments and feedback. IEO organised a stakeholders’ knowledge sharing seminar in Beijing on February 1, 2024, to discuss the evaluation results, findings, and recommendations. The seminar brought together participants from relevant government offices, development partners, NDB project staff, representatives of the NDB Board of Directors, relevant research and academic organizations, non-governmental organizations, foundations and private sector organizations, beneficiaries of the Luoyang Metro project and others.

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## D. Limitations

25. The team faced several limitations during the evaluation. Although the various departments of LRTC had prepared individual departmental reports on safety, environmental aspects, audit, and financial reports, there was no consolidated report that presented a comprehensive view of the project. NDB supervision mission reports were made available, but the information provided therein did not point out some of the key issues emerging during project implementation, including the over-ambitious targets at the project design stage. A Project Completion Report (PCR) prepared by PIA was made available to the team during the process, but this did not fully analyse or examine all facets of the project, especially not the trends in passenger numbers or the revenue generation potential of Metro Line 1. The NDB PCR was not available, even 30 months after project completion. Determining the overall impact on traffic congestion, time saved, and passenger convenience could only be partially determined in the absence of a report that focused on these aspects. Nevertheless, IEO reviewed the large number of reports available both in English and Chinese, which had been produced to piece together a consolidated view of the various dimensions of project performance.

## E. Evaluation Process

26. The evaluation involved the following main phases:
- **Desk Review.** The evaluation team conducted an initial desk review based on available project documents and reports produced by LRTC and NDB. These documents included, inter alia, the Project Design Report, the project and loan agreement and one amendment thereof, supervision reports, and technical reports. Other reports were also reviewed, including audit reports produced by the Henan Provincial Audit Department, environmental safeguards reports, and customer satisfaction surveys produced by third parties. For verification purposes, the evaluation team reviewed secondary data regarding the metro sector in China and the data produced by the Bureau of Statistics on population growth rates, the changing nature of the demographic profile, tourist numbers, and other relevant data on urbanisation.
  - **Field Mission.** The IEO Director General led a mission in September 2023 to collect additional data, visit project sites, hold interviews with key stakeholders, and conduct initial analysis. Among others, the mission held discussions with key government authorities at provincial and municipal levels, as well as with key staff from LRTC and other partners involved in the project implementation. Apart from these, the evaluation team also had direct interactions with resettled households and the project beneficiaries (i.e., passengers of the metro) in Luoyang, as well as the China Association of Metros in Beijing. The evaluation mission visited the project sites, including metro stations, and interviewed various staff working in the different functions of the metro operations. After the field mission, IEO organised a dedicated meeting for discussions with relevant NDB operations staff.
  - **Preparation of the Main Report.** The evaluation team prepared the main evaluation report in September/October after completing the field mission. The draft report was shared with NDB management and the Government for review and comments. In line with the NDB Evaluation Policy, a written management response on the final evaluation report will be prepared by NDB management and incorporated in the report when the final evaluation report is presented to the BoD. IEO will prepare an audit trail to illustrate how the comments provided by NDB management and the Government are addressed in the final report.
  - **Stakeholder Seminar and Board Discussion.** The evaluation report, along with NDB Management Response, will be discussed with the BoD at the end of November 2023. As per established procedure, IEO organised a stakeholders' knowledge sharing seminar to discuss the main evaluation findings, lessons, and recommendations in February 1, 2024 in Beijing.

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- **Communication and Dissemination.** In line with the disclosure provisions of the NDB Evaluation Policy, the evaluation approach paper, final report, and related products will be disseminated through a variety of communication instruments. In particular, the key evaluation products will be made available through the IEO web pages on the NDB website.<sup>6</sup>
  - **Peer Review.** The Asia Pacific Finance and Development Institute in Shanghai served as peer reviewer of the evaluation. They reviewed the draft evaluation report, and their comments have been included in the final version of the report.

<sup>6</sup> <https://www.ndb.int/governance/independent-evaluation/>



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## IV. PROJECT PERFORMANCE

### A. Relevance

27. In line with internationally recognised definitions, the relevance criterion assessed the extent to which, (i) project objectives are aligned with government policies and the needs of the borrowing country as well as with NDB General Strategy and other relevant Bank policies and priorities; (ii) the design of the intervention is appropriate to meet project objectives; and (iii) the intervention has been adapted, as needed, to address changes in the context during implementation.

#### Relevance of Project Objectives

28. **Alignment with Government Policies and Strategies.** IEO found a high degree of relevance of project objectives to the priorities of the borrower country at the national, provincial, and local levels. First, the initiation of a metro system has been included in several government plans since early 2010. It confirms that the project objectives are fully consistent with three of the transportation-related prioritised development plans as specified in the Luoyang City Master Plan 2011-2020 approved by the State Council of China, which are to: (1) construct the Luoyang rail transit network; (2) develop an integrated urban public transportation system with rail transit as the backbone, buses as the secondary, taxi, and other auxiliary means; and (3) construct Metro Lines 1 and 2. As an environment-friendly transportation approach, the project would directly contribute to green transport and clean energy-saving actions as proposed in the 13th Five-Year Plan for Energy Development.
29. The project also fits well with the Plan for Promoting the Rise of the Central Region, in which it is planned that Luoyang would be promoted as a provincial-level sub-centre city and a transportation hub in the central and western regions of China. The Luoyang Comprehensive Traffic Plan 2010-2020 and Luoyang's Five-Year Plan 2016-2020 indicated the aspiration for a modern urban transport system to be established in the city to reduce the burden of the existing transportation infrastructure. This is particularly important considering that Luoyang's urbanisation level is expected to reach 65% over the coming years, with an annual population growth of 3%.<sup>7</sup>
30. **Government Commitment.** NDB provided just over 10% of the total project costs, with the rest of the financing provided by the Government of Henan Province/Government of Luoyang and commercial banks. Hence, the financing plan is illustrative of a high degree of commitment by local stakeholders, which is an important ingredient for success and sustainability.
31. **Alignment with NDB General Strategy and Policies.** The project objectives of providing a safe, reliable, and comfortable means of transport for the commuters in the city are aligned with the key areas of operation of the Bank as specified in the NDB General Strategy 2017 – 2021. In particular, the project sought to directly contribute to NDB's priorities and commitments to support member states in building "transport infrastructure that enhances connectivity between people, markets and services" and "promoting accessible transportation modes with lower emissions and greater energy efficiency."
32. **Alignment with the Sustainable Development Goals (SDGs).** Providing access to safe, affordable, accessible, and sustainable transport systems for all is a well-recognised goal of the international community. Moreover, the construction of the metro also contributed to a reduction in greenhouse gas emissions by helping to reduce motor vehicle and bus traffic, which contribute significantly to greenhouse gases. As such, the project objectives are aligned with SDG 11 of promoting sustainable cities and communities as well as SDG 13 of climate action. It is also aligned with SDG 9 regarding industry, innovation, and infrastructure.

<sup>7</sup> The population size in downtown Luoyang is currently estimated at 2.85 million.

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## Relevance of Project Design

33. The linkages between project outputs, outcomes, and impact were generally coherent. Although NDB intervention was only used to directly finance component 2 of the construction of the LML1, the other two components of the project constituted important parts, including hard infrastructure (i.e., civil engineering construction) and soft infrastructure (i.e., consultancy and capacity building) aspects. In component 2, procurement plans were driven by energy-saving principles, which further reflects the linkages between project components/inputs provided and the expected outcome and impact.
34. **Institutional Arrangements.** The implementation arrangements were coherent and enabled smooth implementation of activities. With strong capacity and leadership, LRTC, as the PIA, put in place all the necessary arrangements, including human resources, training, recruitment of experienced technical and service staff, etc. It also encouraged and facilitated innovation and the piloting of new technologies that enhanced the efficiency of the systems. The project also collaborated with Tsinghua University and the China Association of Metros, hired technically qualified staff who piloted energy-efficient equipment, and further refined precision laser technology for wheel alignment, automatic train operations, maintenance, etc.
35. **Project Components.** The project was structured around three components, with clearly defined and mutually reinforcing activities that would help achieve project objectives. It is noteworthy that component three included capacity-building activities to ensure staff would be properly trained and qualified for the operation of Line 1 and other future lines in the city. Around 11% of total project costs were allocated for capacity building, which is another positive illustration of the importance attributed to ensuring that staff capacities were put in place as part of the design.
36. **Risks and Mitigation Measures.** In accordance with the NDB Environmental and Social Framework, the project was classified as Category "A" for its environmental and social impacts on the resettlement of local residents from the project site, local ecology, and the vibration and dust impacts on cultural relics. The Project Document to the Board included a comprehensive risk mitigation table. Chapter VII of the Project Design Report includes a comprehensive table with 12 identified risks and corresponding mitigation measures. The plan covered different areas, including financial, management, social, technical, environmental, and other risks. These risks were relevant and well-specified.
37. **Summary.** The project objectives were indeed relevant not only to the country and local context and government priorities but also consistent with the broad development goals China has been pursuing. They were also consistent with NDB General Strategy at the time. Considering the over-ambitious targets set up at the project design stage, as further analysed in the section below, the *project's relevance* is rated as **successful (5)** rather than highly successful.

Criterion	Rating
Relevance	Successful

## B. Effectiveness

38. The effectiveness criteria assessed the extent to which the project objectives and targets have been achieved or are likely to be achieved. Other areas that are assessed under this criterion are the extent to which the project supported innovations in response to stakeholder needs and whether the project achieved other objectives or had any unexpected consequence(s).
39. **Project Design and Monitoring Framework (DMF).** As indicated in the NDB Project

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Implementation Guidelines 2018, the DMF is a core element of the project administration arrangements to ensure a logical structure is in place for a result-focused project design.

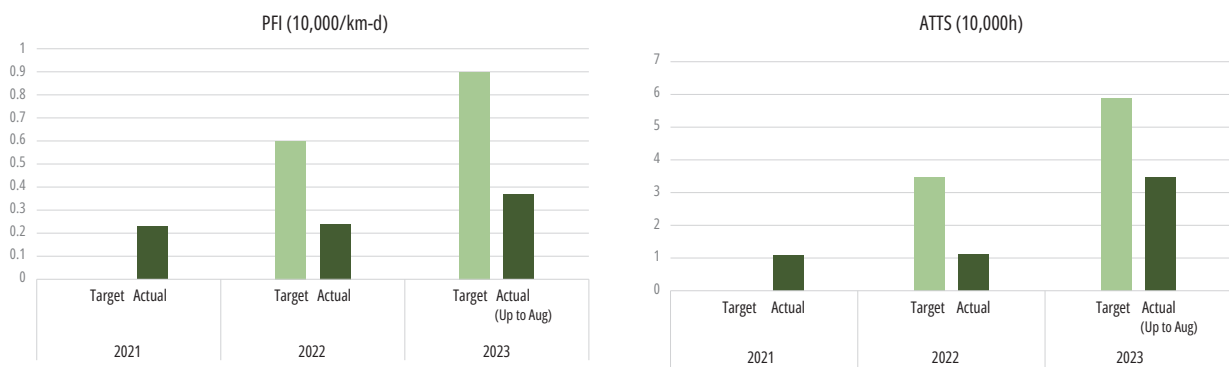
40. However, the DMF for the project only contained six indicators for assessing progress and results, which is quite limited when considering the amount of financing provided by NDB. The indicators in the DMF of the project were not categorised at different levels (e.g., output, outcome, and impact levels) of the results chain. It also lacked some important indicators that could facilitate the assessment of project objectives and benefits, such as those related to a reduction in emission of greenhouse gases and others.
41. In addition, the targets set for some indicators appeared over-ambitious, especially for the passenger flow intensity (PFI) and average travel time savings (ATTS) indicators. According to data from the China Association of Metro, the PFI could not achieve more than 0.9 for cities that have established a mature metro network with multiple metro lines and have operated for years. This confirmed that it was over-ambitious to set the target for PFI in 2023 (the projected second full year after the project completion) at 0.9 in the DMF, especially considering that it was the first metro line in Luoyang.
42. It is recognised that one of the key reasons for setting up some of the over-ambitious targets in DMF was the fact that the preparation of the Project Design Report was largely based on the feasibility study report produced by the China Railway Design Group (an out-sourced technical company recruited by LRTC) which did not sufficiently consider the average three-year passenger cultivation period that is normally needed for citizens to get used to taking the metro as one of the frequently used transportation methods.
43. Notwithstanding the supervision missions conducted, NDB did not conduct any detailed mid-term review (MTR) of the project during implementation, which would have provided an opportunity to adjust the targets in the DMF as needed.
44. Based on the project's intended impact, outcome, and output outlined in the design report, the project's achievement was assessed against the below six dimensions:
  - a) Promote a safe, efficient, speedy, and comfortable means of transportation for passengers and ease traffic problems. To connect the new residential areas to the city centre, providing easy access to a number of commercial centres and historical cultural areas.
  - b) Increase the workforce productivity force and improve the standard of living.
  - c) Have a considerable positive socio-economic impact by promoting reasonable urban layout, improving traffic structure, creating a conducive investment in the environment, and accelerating economic development.
  - d) Reduce carbon emissions and have a substantial positive impact on the environment of the city of Luoyang, including a reduction in environmental pollution.
  - e) Act as a catalyst for future investments in Luoyang.
  - f) Create new opportunities and have a multiplier effect on the local economy. Create jobs during the construction and operations phase to increase the disposable income of the residents, thus increasing the city's economic output.
45. **Promote a safe, efficient, speedy, and comfortable means of transportation for passengers and ease traffic problems.** According to the Project Design Report, it was expected to construct a new underground metro line with a total route length of 22.34 km, having 18 stations in Luoyang with a capacity to carry more than 500,000 passengers on a daily basis by 2046. The completed length of the metro line was 25.342 km, with 19 stations and two underground facilities for train

servicing and maintenance at either end. The project entailed not only the physical construction of the underground tunnels and subways in a heritage site in a congested part of the city but putting in place an elaborate institutional infrastructure, which now employs 2,613 people and has established 13 specialised departments to handle each aspect of the operations, safety, security, ticketing, maintenance, and repair of the system. Between January and August in 2023, the traffic volume of the project reached 22.65 million person-times and 133.28 million person-km, respectively. Hence, this aspect has contributed to meeting the project objective of promoting comfortable transportation for all passengers.

- 46. Passenger Flow Intensity and Average Travel Time Savings.** Five of the six indicators set in DMF are at the outcome level. In terms of PFI (10,000 person/km-day), data shows that the project achieved 0.23 in 2021, 0.24 in 2022, and 0.37 as of the end of August 2023. As mentioned above, the targets of PFI were set unreasonably high (0.6 in 2022, 0.9 in 2023, and 1 in 2024). In this context, the project achieved only 40% of the target in 2022 and 41.1% of the target value by August 2023. The ATTS (1000h) achieved by the project were 31.8% of the target in 2022 and 58.7% by August 2023, respectively.

FIGURE 3

### Analysis of key indicators

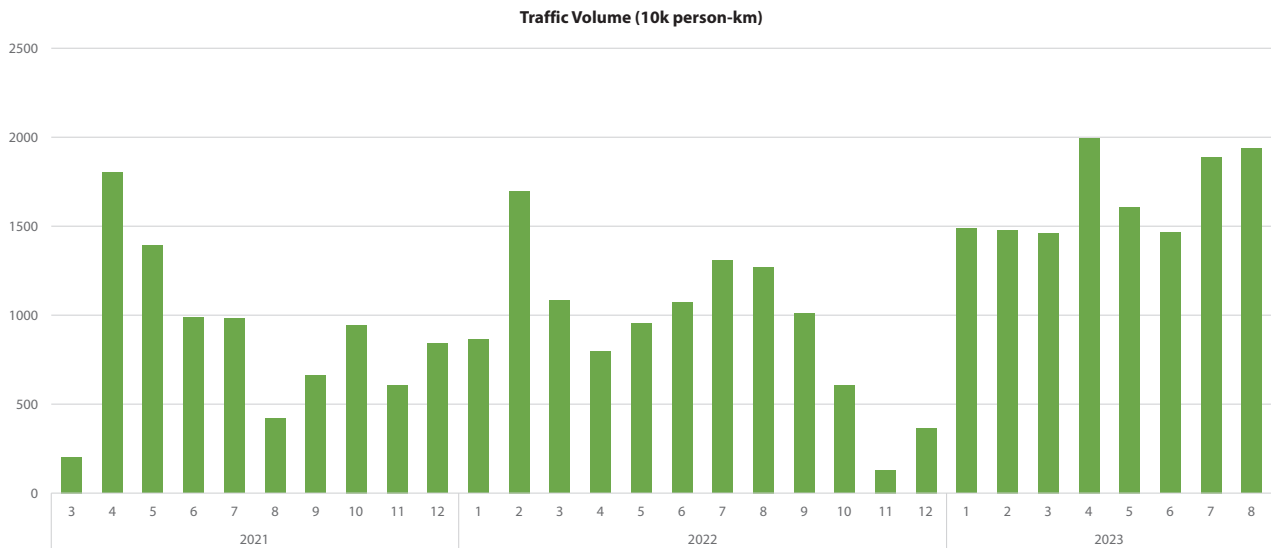


Source: PDB of the NDB in 2018 and LRTC (as of September 2023)

- 47.** Two main factors prevented the project's achievements on PFI and ATTS. Firstly, due to the COVID-19 pandemic between 2020 and 2022, the Government issued travel restrictions, which naturally resulted in extremely low passenger flows in the first two years after project completion. Secondly, as per normal practices, at least three years are commonly needed for passengers to change their transport habits and choices. Considering the COVID-19-related elements, 2023 can, in fact, be considered the first year of the three-year "Passenger Cultivation Period". A positive trend has been observed more recently as the results of PFI and ATTS have dramatically increased in the first half of 2023 by 45.8% and 214.5%, respectively, compared to the results in 2022. Figure 4 below presents the traffic volume of the project and its trend from March 2021 to August 2023.

FIGURE 4

Trend of traffic volume (2021-2023)

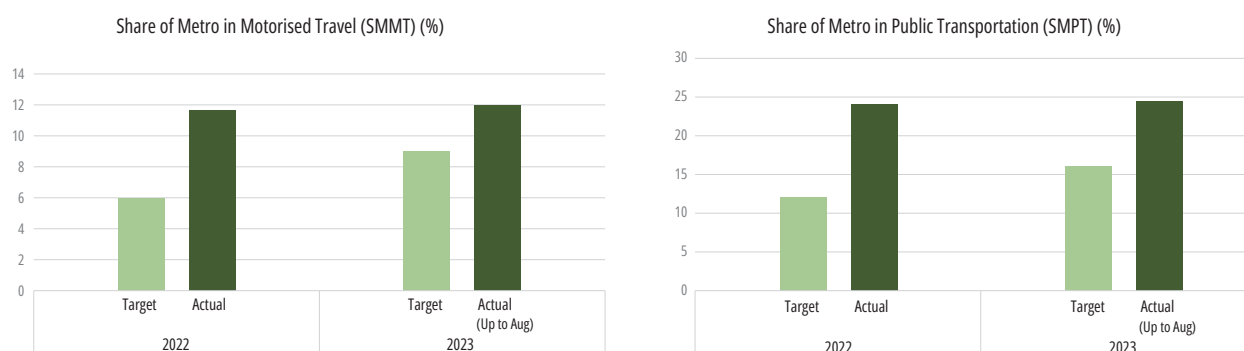


Source: LRTC (as of September 2023)

- 48. LRTC has taken proactive actions to influence the route choice preferences of passengers, which include: (i) promotion initiatives, such as free rides for students during the summer holiday and for all citizens and travellers in Luoyang after 19:00 during a specific period; (ii) launching of the “Luoyixing” pre-paid ticket application with e-tickets which enhanced customer satisfaction; and (iii) providing free rides and discounts under some circumstances; and (iv) integration of public transportation methods including physical integration of the metro stations with the bus system and the “scan to go” bike stations.
- 49. Furthermore, several adjustments have been made in train timings and intervals to facilitate the process. Full integration will need the development of a larger network of metro lines. The interconnection with metros in other cities is being continuously promoted. At present, the interconnection with ten cities, including Wuhan and Shijiazhuang, has been established. Fine-tuning train timings and intervals in train and bus timings have steadily improved the quality of metro operations.
- 50. **Share of Metro in Motorised Travel (SMMT).** The results of the other three indicators in the DMF have exceeded the targets set. Specifically, the SMMT of the project achieved 11.65% in 2022, almost a two-fold increase from the target set in 2022 (6%). The project will likely reach 12% in 2023 and 13% in 2024, compared to the target of 9% in 2023 and 10% in 2024.
- 51. **Share of the Metro in Public Transportation (SMPT).** The target value for the indicator on the SMPT was set at 12%, 16%, and 20% in the DMF in 2022, 2023, and 2024, respectively. According to the most recent data provided by LRTC in 2023, the project achieved 24.13% in 2022, which is also a two-fold increase. It confirms that the LML1 is playing an increasingly important role in integrating the urban public transportation system.

FIGURE 5

### Share of metro in motorised travel and public transport



Source: PDB of the NDB in 2018 and LRTC (as of September 2023)

52. The rate of passenger satisfaction with the project was 98.17% in 2022, which is above the target of 97% in the DMF for the same year. This data is generated from a third-party independent survey conducted by the China Academy of Safety Science and Technology in 2022. (see Annex 10).
53. **With regard to objective (f) above, related to the multiplier effect on the local economy and job creation**, the construction of the metro involved the creation of direct and indirect employment opportunities, which have had a multiplier effect on the local economy as planned. In particular, more than 100 enterprises were involved in the design, supply of equipment, supply of construction materials, logistics, construction, and supervision for LML1, which were provided about 10,000 job opportunities directly and extra employment opportunities indirectly.
54. **Reducing Carbon Emissions.** With regard to objective (d) of reducing carbon emissions and having a substantial positive impact on the environment in the city, the project has led to the reduction of carbon emissions, noise pollution, and air pollution. Due to the construction of LML1, a large number of riders have been transferred from other modes of transportation, such as private cars, taxis, and buses, which has resulted in energy savings and emission reductions. The design and innovations have resulted in carbon emission reductions with a total of 32,843.6 tonnes per year. A summary of the design aspects and the equipment that has contributed to energy efficiency are detailed in Annex 8 and 9.
55. **Positive Socio-economic Impact.** With regard to the objectives of having a positive socio-economic impact (objective c) and, increasing the economic output of the city, and increasing the disposable income of the residents (objective f), there is no specific analysis to link the positive changes in the economic profile of the city to the project. However, there is an improvement in the business environment and employment in the city, foreign investment, and an increase in tax revenue and incomes of residents. During 2018-2022, the disposable income per capita in Luoyang increased to CNY 43,633 from CNY 35,935, an increase of 21.4%.
56. **Increase Workforce Productivity and Improve the Standard of Living.** Customers met by the IEO team reported the convenience and comfort of travelling on the metro and the reduction in travel time. Many of them report increased productivity because of reduced travel time and the ability to work on the metro while travelling. The integration of the various modes of transport has begun to present a seamless travel experience, but more metro lines are needed for greater integration.
57. **Act as a Catalyst for Future Investments in Luoyang.** While the plans for the city included an extension of the metro network once the LML1 was completed, the successful implementation of the project paved the way for rapid expansion of the network. Line 2 is also functioning, and phase II is at an advanced planning stage to serve the purpose of vertically connecting the Luoyang Railway Station and the Longmen High-speed Railway Station. Lines 3 and 4 are also

proposed as a part of the long-term planning. Some of the innovations (below) in the project are being replicated in the expanded network.

- 58. The LRTC also introduced a state-of-the-art information technology system for the sale of tickets through the creation of a dedicated application for the Luoyang subway and the development of information tools for a range of technical functions such as archival management, information communication, etc.<sup>8</sup>
- 59. **Summary.** Overall, the objectives stated in the project design document were achieved ahead of the scheduled timeline. In terms of the DMF indicators, mixed achievements were made with both internal (over-ambitious targets at design) and external (COVID-19-related restrictions) reasons. Since January 2023, positive trends on these indicators have been observed, as reflected in the data as of August 2023. As such, all in all, the evaluation assesses **effectiveness** as **successful (5)**.

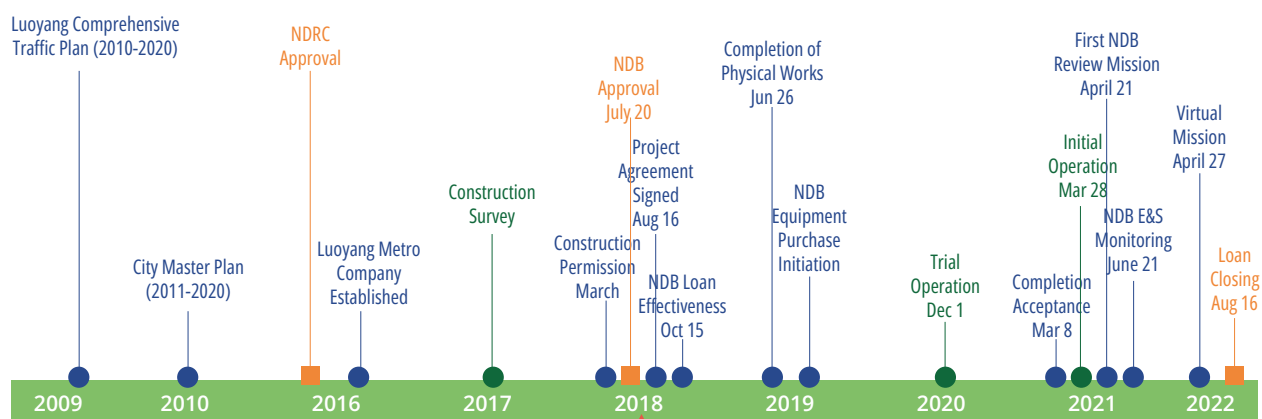
Criterion	Rating
Effectiveness	Successful

## C. Efficiency

- 60. The efficiency assessment focuses on analysing to which extent the NDB intervention delivered, or is likely to deliver, results in an economical and timely way. “Timely delivery” refers to the delivery of results within the scheduled time frame or a time frame reasonably adjusted due to the evolving context. Efficiency also considers operational efficiency – i.e., how well the intervention was managed.
- 61. Early Completion and Successful Operation. The NDB BoD approved the project on July 20, 2018. Within one month, both the project and loan agreements were signed, on August 16, 2018, and became effective on October 15, 2018. This three-month lapse (i.e., 88 days) is far below the average of NDB-financed projects.
- 62. The LML1 has been in operation since March 28, 2021, nine months ahead of the original completion date. This is a notable achievement, especially considering the challenges in relation to the COVID-19 pandemic during the metro construction, including travel restrictions, quarantine, lockdowns, and Polymerase Chain Reaction testing requirements.

FIGURE 6

### Timeline of the Luoyang Metro Line 1 project



Source: LRTC (as of September 2023)

8 Details in Annex 2.

**63. Budgeted versus Actual Expenditure:** An assessment of the budgeted with the actual expenditure shows that overall, the project used just under its budgeted costs. The most significant difference in terms of the main components was the increase in construction cost of 34% due to the difficult geological conditions and the need to monitor and protect cultural heritage underground. This was made up by the savings of 8% in equipment costs, 9% in land acquisition and consultancy costs, and the much lower interest costs incurred during construction. The project costs were overall 1% less than its initial budget due to the strengthened management and innovation of the project’s engineering design and construction.

TABLE 3

**Budgeted vs actual costs (CNY million)**

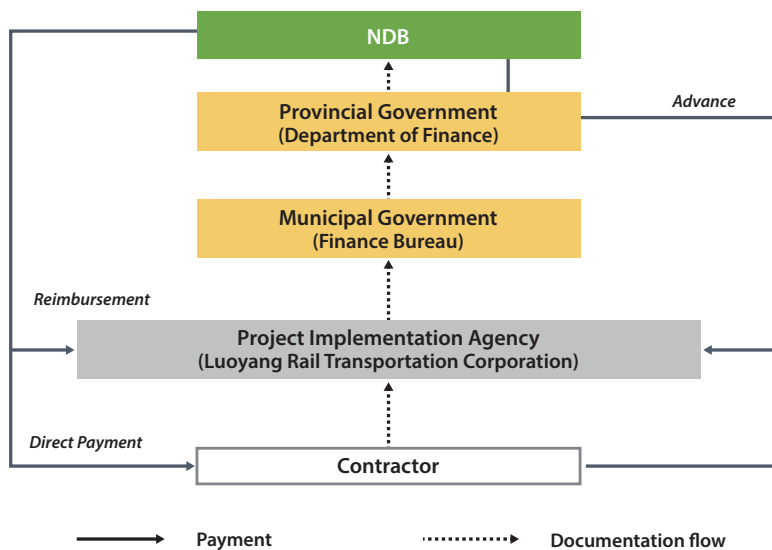
	Budgeted	Actual	Difference	(%) Variance
Component 1: construction of Line 1	7,348	9,834	2,486	34%
Component 2: equipment	4,412	4,080	-332	-8%
Component 3: land acquisition and consultancy	3,245	2,954	-291	-9%
Contingencies	1,411	0	-1,411	-100%
Interest during construction	1,690	955	-735	-43%
Initial working capital	14	102	88	629%
<b>Total</b>	<b>18,119</b>	<b>17,925</b>	<b>-194</b>	<b>-1%</b>

Source: LRTC (as of September 2023)

**64. Disbursement and Procurement.** The disbursement rate was 100% at completion. The loan was closed on August 15, 2022, as stipulated in the loan agreement. This is a significant achievement given that the project had to disburse close to USD 300 million within a fairly short span of time. NDB disbursement was even faster by the designated account. The first procurement notice was published on February 12, 2019, and the last supply contract was signed on September 7, 2020, indicating that a total number of 21 contracts were published, awarded, and signed within one year and seven months.

FIGURE 7

**Funding flow of NDB financing**



Source: PDB of the NDB in 2018



65. Systematic mechanisms were established by LRTC to facilitate the process of undertaking and obtaining approvals, procuring technical expertise, and initiating the survey of both the physical aspects of the project and other elements in relation to human resource management, procurement, financial management, resettlement, etc.
66. During the preparation of the project, various policies and compensation measures that set high standards for dealing with issues related to land requisition, demolition, resident relocation, and municipal pipeline relocation were put in place. To enhance quality assurance, 28 standards and regulations for quality management have been published by LRTC, including Measures for Quality Management of Construction Projects (Trial), the Standards of Construction Sites Management (Trial), and the Measures of On-Site Engineering Materials Quality Management (Trial). It is confirmed that these standards and regulations issued by LRTC largely secured the quality of the construction and installation works.
- 67. Economic and Financial Analysis.** As the PCR by NDB operations is not yet available, the evaluation team conducted an economic analysis by adopting the same method used at appraisal. The Project Design Report provided incomplete information on the economic evaluation of the project. For instance, no economic evaluation table was presented in either the main text or the annex. In this case, the results of the economic analysis conducted by the evaluation team were compared with the results of the data provided in the Feasibility Study Report.
68. At appraisal, several other types of benefits were identified, monetised, and included in the evaluation. These included passenger time savings, which were calculated using the difference between the time taken to travel by bus and subway and the value of time saved by assigning a value of CNY 37.30 per person per hour and increasing this by 6.5% per annum. The economic value of increased travel comfort was assumed to lead to an increase in labour productivity by 4% using the International Organization for Standardization's estimates. The third benefit was the reduction of road accidents, which were computed as reduced costs of repairing damaged vehicles, medical costs avoided, and reduction in traffic disruptions, and the fourth benefit was the reduction in bus investments and operating costs. The benefits did not include the projected increase in tourism traffic that is attracted due to the convenience of travel, the multiplier effects that this generates, the growth in enterprise and employment creation along the metro lines, and the monetary value of the carbon emissions that have been potentially avoided. The inclusion of these benefits will enhance the rate of return.
69. Based on the data provided by LRTC in September 2023, the re-evaluated Economic Internal Return Rate stands at 11.11%, higher than 10% of the hurdle rate at appraisal. The Economic Net Present Value (ENPV) is CNY 8,382.03 million. The results are similar to those given in the initial analysis, which showed an Economic Internal Return Rate of 11.15% but a much lower ENPV of 1,813.75<sup>9</sup> million at design. The re-calculated Economic Internal Return Rate and ENPV results confirmed that the project remains viable at appraisal. On the other hand, this analysis does not include many of the benefits that are expected from tourism or the multiplier effects generated by ancillary services.
- 70. Project Management Costs.** A good proxy for project efficiency is to assess the amount of project costs devoted to "management" purposes. In this case, the main cost in component three was for "pre-stage work, design surveys, revisions, and capacity building," which was around 11% of total project costs. This is well within acceptable international norms for management costs. The major share of the costs was spent on implementing components one and two, the project's core.
- 71. Summary.** The project was implemented during the COVID-19 pandemic, which brought numerous challenges. Despite these external elements, the project was completed nine months

9 The values are somewhat anomalous, with the Economic Internal Return Rate in the Project Document to the Board having the same value as the Economic Internal Return Rate in the feasibility study report, while the ENPV is less than a quarter of the ENPV in the feasibility study report.

ahead of the original completion, and the actual project cost was lower than the original design. The fast start-up, including recruitment and training of staff starting at the appraisal stage, and the current initiation of many different aspects of the project such as land acquisition, staff headhunting and training, initiation of compensation activities, research, and development on information technology, etc. indicated the comprehensive approach of the project which further contributed to the efficient execution. It also confirmed the strong capacity of the PIA and the joint effort among PIA, government authorities, and NDB operations staff. The evaluation rates **efficiency as highly successful (6)**.

Criterion	Rating
Efficiency	Highly Successful

## D. Impact

72. Impact is concerned with the extent to which the project has generated significant positive or negative, intended or unintended, higher-level effects.
73. LML1 has had a significant impact on the city due to the fact that it has provided the impetus for establishing a metro network for the city. Government authorities confirmed that the successful operation of the LML1 further facilitated the construction of Metro Line 2. In the second phase, an additional 18 km was constructed for Luoyang Metro Line 2, serving as a north-to-south route with 15 stops, connecting the city's two major existing transportation hubs: the Luoyang Railway Station and Luoyang Longmen High-speed Railway Station. The new line also serves several other business centres in the city, including the National Peony Garden, sports centres, and museums.
74. The onset of COVID-19 led to much lower rider numbers after the first two years of the project completion. However, it has been observed that the number of passengers has begun to grow. The social impact that accrues for the passengers varies from different aspects. There is a reduced commuting time for passengers and increased productivity for students and workers who claim that they can productively use the travel time (e.g., by reading). Some of the retired passengers reported that the convenience offered by the metro encouraged them to go out more for leisure, sightseeing, and visiting family and friends. The project's impact on reducing congestion has not been measured by the PIA, as the indicators on this aspect were not included in the design.
75. **Positive Socio-economic Impact.** With regard to the objectives of having a positive socio-economic impact (objective c) and, increasing the economic output of the city, and increasing the disposal income of the residents (objective f), there is no specific analysis to link the positive changes in the economic profile of the city to the project. However, there is an improvement in the business environment and employment in the city, foreign investment, and an increase in the tax revenue and incomes of residents. During construction and operation, the project created about 10,000 job opportunities directly and a lot of jobs indirectly. The Luoyang Rail Transit Group has 2,613 regular employees, of which 1,431 staff are fully dedicated to the operation of LML1, including 360 female staff. In addition, 1,832 workers were recruited (on non-regular contracts) to support LML1, performing the functions of security, cleaning, maintenance, etc.
76. The staff turnover rate has been comparatively low in the past three years, at 0.29% in 2020, 3.22% in 20220, 3.54% in 2022, and 2.79% by September 2023. This indicates a strong motivation and commitment to continue working in the company.
77. **Increase Workforce Productivity and Improve the Standard of Living.** Passengers met by the IEO team reported the convenience and comfort of travelling on the metro and the reduction in travel time. Many of them reported an increase in productivity due to the reduction in travel time as well as the ability to work on the metro while travelling. The integration of the various

modes of transport has begun to present a seamless travel experience, but more metro lines are needed for greater integration.

78. **Increasing Tourism.** The metro line passes through several famous ancient cultural and tourist sites in Luoyang. During the tourist season, metro passenger traffic volume surges. During the Luoyang Peony Festival in April 2023, the project traffic volume reached 3,415,500 person-times, a 45% increase from March. The traffic volume reached 266,100, the maximum peak on April 30, 2023. The project is driving the development of Luoyang's tourism industry and supporting the construction of Luoyang as an internationally renowned tourist city.
79. **Act as a Catalyst for Future Investments in Luoyang.** While the plans for the city included an extension of the metro network once the LML1 was completed, the successful implementation of the project paved the way for rapid expansion of the network. Line 2 is also functioning, and phase II is at an advanced planning stage to serve the purpose of vertically connecting the Luoyang Railway Station and the Longmen High-speed Railway Station. Lines 3 and 4 are also proposed as a part of the long-term planning. Some of the innovations of the project, which have been further elaborated below, are being replicated in the expanded metro network.
80. **Urban Climate Resilience.** The project enhances the resilience of the infrastructure in Luoyang by providing an all-weather public transportation mode to prevent from the risk of extreme weather. As an all-weather public transportation facility, the operation of LML1 under extreme weather (e.g., heavy rainfall with precipitation exceeding 100 mm in one day) has demonstrated its resilience under extreme weather conditions.
81. **Carbon Emission Reductions.** The project applied energy-saving design and technological innovations, which resulted in carbon emission reductions with a total of 32,843.6 tonnes per year.

FIGURE 8

### The latest operation diagram



Source: LRTC (as of September 2023)

82. Overall, the project impact is considered positive based on the results achieved within a short period after the completion and without the influence of COVID-19-related factors. The project has been very innovative in terms of its investments in energy efficiency, information technology, and the systems of O&M, customer orientation, and satisfaction. The project is expected to be an example for other metro projects to emulate and scale up. Given that the project has achieved its main objective of a modern and efficient transport system for the city that will lead to economic growth and is environmentally friendly, IEO rates its **impact** as **highly successful (6)**.

Criterion	Rating
Impact	Highly Successful

## E. Sustainability

83. Various elements of sustainability were examined, such as technical operations and maintenance, and financial and environmental sustainability. Within the LRTC, a state-of-the-art Maintenance Engineering Department (MED) oversees operations, has the technical capacity for the task, and continues to recruit and train technical staff. The permanent staff of the LRTC and their continuous training and capacity building are other aspects that ensure the project's sustainability.
84. Metro projects are urban public welfare infrastructure projects in China. Like the metro projects in other cities, the LML1 is not financially sustainable at the moment and cannot finance its debt liabilities or operations. In this context, the financial responsibility has been assumed jointly by the Henan Provincial Government and the Luoyang City Government. Both governments provided a subsidy of CNY 524 million in 2021 and CNY 743 million in 2022, respectively, for the project O&M. There is a strong commitment by the State to subsidising metro operations for the public good. Nevertheless, there are plans to generate revenue from ticket sales and supplement the income by renting out space for retail outlets and advertisements.
85. The LML1 and 2 stations have a total planned underground commercial area of 168,000 square meters, an underground parking lot of 138,500 square meters, and an external store property area of 75,300 square meters. Revenue can also be generated through metro print advertisements, passenger information system advertisements, screen door advertisements, and voice advertisements. The revenue from these investments and facilities is expected to be around CNY 299 million per year.
86. Plans have been put in place by LRTC for the operations, maintenance, financing, and expansion of the metro network in the city, including its integration with other modes of transport. While these plans are incorporated in the overall plan of Luoyang city, it appears that they were not shared with NDB. No commitment was also undertaken regarding documenting, tracking, or monitoring the project's progress and impact over time. It could have provided opportunities for both the city and NDB to learn from the unfolding experience of the project. While the sustainability of benefits appears to be largely assured, an explicit exit strategy would have clarified the roles and responsibilities of different partners in post-project activities to ensure the sustainability of benefits, which is at the core of NDB financing.
87. **Innovation.** Ventilation and air-conditioning systems account for 40% of the total energy consumption in metro stations, constituting a key focus of energy efficiency. The LRTC piloted an innovative technology in Mudan Square station and Jiefang Road station of LML1, where the cooling source of air-conditioning and ventilation systems are divided into public areas (large system) and equipment areas (small system). The magnetic levitation compressor and terminal water-cooled direct-expansion refrigeration (LEV-DER) are adopted for large systems, and the air-cooled multi-connected unit is adopted for small systems. Further, a platform screen door, with an open-able screen door upper mounting device, is adopted to reduce the air-con refrigeration load of the large system. In public areas, inverter air-con systems are introduced to utilise the train piston wind in the tunnel to regulate the station's temperature. After separating large and small systems, the station reduces energy consumption by about 40% and does not exceed 350,000 kWh annual power consumption per standard station. After this new technology was applied and verified, it has been upscaled to the 14 Luoyang Metro Line 2 stations, and there are plans for its scaling up in new metros.

TABLE 4

## Energy efficiency

	Reduction in energy consumption (kWh)	Operation cost savings (CNY/year)	Reduction in carbon emissions (tonnes)
Convertible ventilation conservation module	732,000	410,000	418
Magnetic levitation compressor + terminal water-cooled Direct-expansion Refrigeration (LEV-DER) Module pilot in LML1	240,000	156,000	137
LEV-DER technology	1.17 mn	657,440	670
Efficiency of operations stations of Luoyang Metro	5.1123 mn	2.863 mn	29,155

Source: LRTC (as of September 2023)

88. Based on the above, the evaluation rates **sustainability** as **successful (5)**, given that the operation of the project is technically and institutionally sustainable. Its ability to generate financial resources from its revenues is expected to be realised in the future.

Criterion	Rating
Sustainability	Successful

## F. Compliance

89. **Environmental and Social Safeguards.** NDB has developed an Environment and Social Framework and Environment and Social Standards for its borrowers to implement projects in an environmentally and socially sustainable manner. The LML1 project was classified as Category “A” in accordance with NDB’s Environment and Social Framework. The key environmental and social impacts identified as part of the legal requirements in China pertaining to the resettlement of residents from the project site, pollution of a protected water source in the city, and vibration and dust impacts on cultural relics. NDB assessed the mitigation measures proposed by the PIA according to the country’s systems and found them in line with NDB’s Environment and Social Framework requirements. As part of the agreement with NDB, to ensure compliance with the country systems, the PIA monitored the socioeconomic status of the resettled people post-relocation. NDB also monitored the project closely and engaged with the PIA during implementation. In February 2021, a third-party company, JJT Group Co. Ltd (recruited by the Transportation Bureau of Luoyang), produced a detailed completion environmental protection assessment survey and examined the various dimensions of the project, including its impact on water use and drainage, acoustic, atmospheric, solid waste management, and ecological aspects. No adverse issues were reported, and no public complaints were received.
90. **Financial Management and Procurement.** Pursuant to the Loan Agreement (Loan No.: 18CN02), the Loan became effective on October 15, 2018, with the loan closing date of August 16, 2022, and the account closing date of February 16, 2023. Luoyang Rail Transit Line 1 complied with the Loan Agreement and submitted an audit report to the NDB in accordance with the audit system within six months after the end of each accounting year to confirm the use of the loan funds, paid front-end fees, commitment fees, interest, and other fees on time according to the terms of the loan agreement. According to the approval document of the BoD of the NDB, the total investment of Luoyang Rail Transit Line 1 was CNY 18,119 billion, i.e., USD 2.775 billion (the exchange rate is calculated at CNY 6.527/USD). In the actual bidding process, the total investment of Luoyang Rail Transit Line 1 was RMB 17.925 billion, i.e., USD 2.746 billion, due to savings on the control price and line adjustment.

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## G. Monitoring and Evaluation

91. As stipulated in the Implementation Guidelines, NDB has an established system for monitoring project performance during implementation, including the DMF, semi-annual project performance assessment, regular supervision missions, midterm review missions, and completion review missions. The Project Design Report indeed included a DMF. NDB uses a semi-annual project progress assessment to evaluate the project progress. However, M&E was not used as a key management instrument by LRTC or NDB for making timely adjustments to the DMF targets and indicators and documenting experiences and good practices to foster learning.
92. At the same time, it was observed that although LRTC maintained a large amount of records during project implementation, each of the departments of LRTC generated key information separately without consolidation at the project level. The reports included the following:
  - a. To ensure the stable operation of the equipment of Line 1, the Maintenance Engineering Department has put in place systems to strengthen the management of key operational indicators. In the trial operation stage, it organised technicians of various disciplines to intervene in the regular maintenance of equipment in advance, incorporated the equipment of Line 1 into the production plan of each discipline, carried out regular maintenance and equipment maintenance under the guidance of technicians of manufacturers and departments, and rectified the problems and hazards found in a timely manner. During this period, a series of fault simulation and emergency drills were also held to verify the reliability of the equipment further and test the practical operation and emergency response capabilities of dispatching, station service, crew, and equipment maintenance personnel. LRTC ensured the equipment was adjusted to the operating conditions during the trial operation. Since Line 1 was put into operation, the Maintenance Engineering Department has monitored the integrity indicators of service facilities, which are all superior to the national standards.
  - b. LRTC has the capacity to produce very specific information on many aspects of its operation, including safety, breakdowns, environmental and energy consumption, technological innovations, revenue and employment generated, staff retention, attrition, and promotion etc. LRTC has put in place systems for tracking passenger's real-time data and has also been tracking the daily, monthly, and annual passenger flow and its trends. The energy savings, employment generated, revenue flows from ticket sales and advertisement, and rental income have not been presented in a consolidated manner. An analysis of the passenger flow and trends and the increase in the revenue from the operations of the metro line and other revenue generated could assist in better understanding the economic and financial performance of the project. It will be useful for LRTC to present a consolidated picture of the changing use and impact and the financial and operational sustainability of the Luoyang City Metro over time. Valuable lessons could be derived from monitoring and tracking the data over time.
  - c. LRTC submitted eight project progress reports (PPRs) during implementation and the PCR when the project was completed. The evaluation team received four PPRs from the NDB operations department and four from LRTC during the evaluation mission in the field. The quality of PPRs was mediocre, and the quality of PCR needs to be improved since the key information, such as the achievements of the indicators and target values, was weak. That means LRTC could have benefited from technical assistance in the preparation of the PCR and PPRs from the NDB operations team.
  - d. As mentioned, NDB did not undertake any MTR, and the NDB PCR has been delayed significantly. Given the weak DMF and lack of an explicit theory of change, the project design was not adequately evaluable. These are important topics that need to be covered in future operations.

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## H. Overall Project Achievement

93. “Overall Project Achievement” is a composite criterion comprising the five core criteria used in this evaluation (relevance, effectiveness, efficiency, impact, and sustainability). The rating assigned to Overall Project Achievement is not an arithmetic average of the ratings assigned to the other evaluation criteria. Instead, the rating for Overall Project Achievement is informed by the ratings of the five core criteria and reflects IEO’s holistic judgement based on the evidence available of the project’s achievements and room for improvement.
94. The highly successful ratings for project efficiency and impact are particularly noteworthy and are distinguishing features of this operation. It is a remarkable achievement, given that no other NDB-financed project evaluated by IEO thus far has achieved such high ratings for efficiency and impact, respectively. The lessons and good practices from the Luoyang Metro project in ensuring efficiency and promoting impact should be carefully examined, and opportunities for replicating the good practices should be explored in other NDB operations in China and beyond.
95. As shown Table 5 below, the **overall project achievement** is considered **Successful (5)**.

TABLE 5

### Summary of evaluation ratings

Criterion	IEO Rating
Relevance	Successful (5)
Effectiveness	Successful (5)
Efficiency	Highly Successful (6)
Impact	Highly Successful (6)
Sustainability	Successful (5)
<b>Overall Project Achievement</b>	Successful (5)

Source: NDB (as of September 2023)

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## V. OTHER EVALUATION CRITERIA

### A. Performance of NDB

96. The assessment of NDB's performance covers the entire project cycle, including technical support, monitoring and supervision, self-evaluation, knowledge management, and others.
97. **Project Design.** Building on the technical proposal prepared by government authorities, NDB conducted an identification mission for two days in November 2016. The then NDB Vice President for Operations took part in the mission, reflecting the commitment of NDB senior management towards the investment. Thereafter, the NDB project design team conducted an appraisal mission for about 15 days in September 2017 with a multi-disciplinary team consisting of eight members, including a technical consultant. Subsequently, a follow-up mission was conducted in November 2017 to fine-tune some design aspects. This is illustrative of the active role played by NDB during the design process.
98. Despite this hands-on role, the due diligence and appraisal of the project conducted by the NDB project design team could have been strengthened to identify issues in its design framework, including the quality of selected indicators for performance assessment and the targets set up at design. Specific examples of the absence of such efforts include the fact that there was very limited information about the economic evaluation of the project in the Project Document to the Board, and no economic evaluation table was provided.
99. A short project agreement was signed by the NDB President and the Government of Henan Province in August 2018, summarising the main aspects of the operation, and the loan agreement was also signed on the same date between the NDB and the Ministry of Finance of China. The loan agreement is rather short and focuses mostly on financial aspects, whereas the project agreement includes more details of the operation and obligation of the provincial authorities.
100. **Supervision by NDB.** NDB maintained a light-touch approach to project monitoring and supervision throughout implementation. It conducted only three short review/supervision missions. The first of the supervision missions was conducted two and a half years after the loan agreement was signed. The supervision reports are not well structured and repeat much of the same basic information with limited analysis. The gap in the targets with respect to indicators such as PFI and ATTS was not identified during the supervision missions. As a consequence, no revision of targets was proposed to address this issue in a timely manner. No MTR was conducted, and the PCR has also yet to be prepared by NDB, two and a half years after project completion.
101. **High Turnover of NDB Staff.** Continuity of staff is essential, inter-alia, to maintain a strong dialogue with implementers and other stakeholders, learn and share lessons, follow up on previous supervision mission findings and recommendations, and so on. However, in a relatively short period of time, there was a high turnover of staff responsible for the project within NDB, which could have been a factor for the lack of proper analysis and the mixed quality of supervision reports produced during implementation. The social and environmental aspects were reviewed towards the final years. But, this analysis was cursory and lacked substantial depth. The strong performance of the project and the corresponding lessons and good practices were not adequately captured and documented by NDB, which may also be partly attributable to the high staff turnover.
102. **Procurement and Disbursement.** NDB did well in terms of its oversight of procurements and disbursements. There was regular review of the procurement documents and timely disbursements. In this respect, NDB's performance was reported to be much more efficient



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compared with other multilateral financing institutions. There was much appreciation for the disbursement process within NDB.

- 103. Knowledge Management.** After project completion, NDB produced some knowledge products (e.g., demonstration videos). At the same time and as mentioned above, the positive lessons that emerged from the superior performance of the project based on its strong planning, coordination, and advance planning were barely noticed. The project's performance on energy efficiency was reported in a perfunctory manner in the supervision reports, and its achievements in information technology, resettlement, and human resource development went unnoticed. There is much that NDB could have learned and disseminated about the LML1 project. This can be done even now by developing and sharing specific knowledge products such as brief notes and brochures on specific aspects of the project as technical guides.
- 104. NDB Visibility.** NDB's financing, as well as the flexibility it provided during implementation, was highly appreciated by the Government at both the local and provincial levels despite the fact that it contributed only a small share of the total project cost. As the first multilateral development bank established entirely by emerging markets and developing countries, it is expected that the value provided by NDB is not just for financing but also for technical guidance, innovation, and knowledge generation and sharing. The supervision missions were too short to make a real contribution, and the level of engagement did not lead to the provision of any technical inputs on monitoring or evaluation. A short video on the project was indeed produced and published on its website; however, NDB has not yet organised any knowledge events about the project and therefore lost the opportunity for high visibility in a project that is highly valued and considered a success. Considering the above, **NDB performance** is rated **moderately successful (4)**.

## B. Borrower Performance

- 105. The borrower's performance has been a cornerstone of the project's success.** As this was the first metro line in Luoyang City, the provincial government and the LRTC paid high attention to it, and all government departments actively cooperated with the project. The key challenges, such as land acquisition and demolition, municipal pipeline relocation, and reconstruction, were dealt with very well and efficiently. For benchmarking against high-quality standards implemented in other cities, LRTC and its implementing partners investigated, communicated, and studied previous projects and invited expert consultants to introduce their experience in the construction of the Luoyang Metro Network.
106. During the construction of LML1, the LRTC strictly controlled the construction progress nodes, closely crossed the previous and next processes, rationally utilised Building Information Modelling technology, optimised the construction organisation plan, and completed the construction tasks in advance to ensure safety and quality. All payments to the contractors of the project were processed through the designated account. The Henan Provincial Finance Department managed the designated account and processed the loan withdrawals and reimbursement applications in a timely and efficient manner. The Ministry of Finance in Beijing provided timely support and broad oversight of the operation.
107. One of the key drivers of positive achievements was the high levels of commitment demonstrated by all implementing partners and the active coordination of activities across institutions, also leading to superior levels of efficiency in delivery. The borrower undertook a comprehensive approach in concurrently initiating this complex project's different elements, thereby ensuring its timely completion.
108. Progress reports were prepared by the borrower during implementation and submitted to the NDB in a timely manner. A PCR prepared by the PIA was also submitted on time. While some of the reporting quality was mixed, the borrower could have invested more in M&E and knowledge management. The **borrower's performance** is nevertheless rated as **highly successful (6)**.

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# VI. CONCLUSIONS AND RECOMMENDATIONS

## A. Conclusions

- 109. Storyline.** The LML1 project has generally been a successful operation. The project was completed nine months before its scheduled completion date and used less than anticipated resources. The project completed 25.342 km of Metro Line 1 with 19 subway stations. The Luoyang Metro's achievements are not just confined to the construction of a state-of-the-art metro line in record time, but more importantly, it is a story of how a mammoth institutional and operational structure was created to ensure the safe and efficient management of the system. The project used the highest technical standards for O&M of trains, incorporated energy efficiency technology, introduced very sound principles of customer care, resettlement, compensation of construction workers, and spearheaded the development of a range of digital products for passenger use and for backend support that are now being patented. The project provides a model for implementing infrastructure projects in many respects and highlights the importance of a supportive and coordinated ecosystem.
110. The experience of the LML1 project demonstrates that the existence of a strong supportive ecosystem is vital to the success of a project. The development of the metro project received the highest level of support from State institutions and is a testament to the very strong regulatory, technical capacity, and quality standards that have been established and are continuously being refined in China for something as sophisticated and complex as an underground metro in a congested and historic city. Few countries have such well-developed and supportive systems; therefore, it is important to determine the country's capacity for implementation while selecting projects.
111. While the pandemic negatively impacted the number of metro riders, the numbers are gradually increasing. The current daily average is close to the number estimated in the feasibility study and reached 22.6 million on an annual basis in 2023. Greater passenger traffic is being encouraged through integration between the metro and the bus routes, which has been initiated through a range of measures such as changing train timing and intervals, bus routes, and locations. The use of the metro is very high during the Chinese holiday and festival season and reached 3.37 million passengers during the school break in August 2023 (see Annex 11).
- 112. The project achievements can be attributed to the high level of commitment and coordination at all levels.** The success of the Metro Line 1 Project demonstrates the importance of strong commitment and coordination between a range of public and private agencies with the capacity for planning, designing, financing, implementation, and management of the project. A high degree of technical and institutional support was provided by a range of State planning, financing, and regulatory institutions working closely with both public institutions and the private sector in China.
- 113. The strong institutional arrangements on the ground were key for the planning and execution of the project.** A two-level institutional structure was erected from scratch, with the overall responsibility of project management and coordination entrusted to the Luoyang Metro Group Corporation and the Luoyang Urban Rail Construction Command Office and the implementation responsibility entrusted to the LRTC, a new organisation established at the end of September 2016. LRTC created 13 functional departments to monitor and manage the project, including project design, site selection, land acquisition, fundraising, resettlement management, equipment selection and procurement, civil works procurement, construction supervision, and completion acceptance.
- 114. The Luoyang Metro Group Corporation adopted a comprehensive approach and initiated**

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- all preparatory activities at the outset.** The measures included the arrangements that were needed for institutional development, land acquisition, resettlement, design, construction, procurement, etc. The concurrent planning and implementation of the diverse aspects ensured timely completion.
- 115. The human resource planning and development strategy was a major factor in the project's success.** The LRTC management had the foresight to approach the leading universities and technical training institutes and register with them their need for technical staff in different aspects of the metro starting in 2016/17 to ensure they had a trained workforce in place. The headhunting for appropriate staff, their recruitment, training, deployment, and retention has resulted in a workforce of 2,613 workers, with 27% being women and an attrition rate of only 3%.
- 116. Strong procurement capacity was another driver of success.** LRTC had put in place a strong procurement capacity through in-house expertise to initiate the procurement processes in close interaction with NDB and outsource the function to a qualified procurement agent, namely the Guoxin Tendering Group Company, for the procurement of equipment and supplies. This led to a well-planned system that ensured the timely availability of all equipment and supplies. The procurement of goods included training of the technical staff for the operation of the equipment and adequate guarantees to ensure equipment functionality.
- 117. The PIA piloted the use of energy-efficient air conditioning systems, which have become a model for upscaling.** The LRTC has been the first to install energy-efficient air-conditioning and lighting equipment, which can save up to 35% of the energy used in subway stations, leading to cost savings and reduction in carbon emissions. This has entailed considerable savings for the LML1 and also served as a model for replication for LML2 and other metros (Annex 9). The China Association of Metros confirmed that this technology would be replicated in all new metro stations as a best practice.
- 118. The use of information technology in the project has led to higher levels of customer satisfaction.** The new metro has incorporated state-of-the-art technology to facilitate the metro customers. A dedicated mobile application has been developed to facilitate ticket purchase and payment through digital finance. Additionally, face recognition is utilised for customer identification to enable them to avail of discounted fares. A third-party survey reported no grievances and high levels of customer satisfaction (98%) (Annex 10).
- 119. The approach to resettlement and relocation of households and businesses followed a very consultative approach that adopted very high service orientation and customer care standards.** The affected households were given the choice of receiving cash compensation or physical housing. Most households have been compensated or settled, with the last few households expected to be settled by the end of 2023. The evaluation team met with selected members from the affected households who confirmed the timely payments that were made in case of rent payments, compensation, and relocation based on close consultations with the affected households.
- 120. The LRTC mechanism of compensating wage labourers has established a strong reputation for the company, incorporating worker concerns and ensuring their social security.** The LRTC ensured that the more than 10,000 workers involved in the project's construction through private companies were paid monthly in bank accounts, which were opened for each worker.
- 121. Integration of the various modes of transportation has been initiated but requires a larger metro network and can only be achieved over time.** LRTC has been striving for the integration of its subway, bus, railway, motor vehicle, and e-bike system through the careful initial selection of the metro stations along existing bus routes, establishing parking lots, adjusting subway and bus timings and intervals in a manner which supports the integration of the various modes of transportation in the city. The metro and bus tickets can be used interchangeably to further facilitate passengers.

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- 122. Value addition of NDB in reviewing project design and examining those aspects that could have added value based on its mandate.** Such a review could have helped to put in place a stronger system of M&E of impact, sustainability, gender, and climate resilience.

## **B. Recommendations**

**Recommendation 1:** *The need to strengthen project evaluability.*

123. There is a need to strengthen NDB-financed project evaluability for assessing results, generating lessons, and promoting greater impact and sustainability. Among others, this would need Project Design Reports to include an explicit theory of change, clearly and explicitly defined project objectives in a dedicated section of the report, a coherent set of indicators listed in the DMFs at different levels of the results chain, and realistic targets, provisions for regular supervision during implementation, an MTR conducted in all cases, once during project implementation - a provision which should be included in loan agreements; and the preparation of PCRs by the NDB in a timely manner.

**Recommendation 2:** *A sharper focus on green and climate-resilient technologies and innovations.*

124. NDB should ensure a sharper focus on the extent to which its investments lead to the adaptation of green and climate-resilient technologies and innovations. This can be done by promoting the inclusion of these criteria in the identification and selection of projects for financing, including specific clauses and monitoring indicators in the project financing agreements, as well as terms of reference of supervision missions, among others.

**Recommendation 3:** *Strengthening the value additions of the Bank at project design.*

125. In designing new projects, sufficient attention should be given to ensure the design document adequately reflects the added value that the financing provided by NDB could bring to the borrower country and the project. This would maximise the impact of NDB at the country and project level and would further strengthen NDB's role not only as co-financers of development projects but, more importantly, as a multilateral development bank with internationally recognised standards and practices, in particular in the areas of social and environmental aspects.

**Recommendation 4:** *Improving project implementation support and supervision.*

126. More regular and in-depth supervision of projects should be undertaken to follow up on some of the emerging insights in a timely manner and capture the opportunities to enhance impact. NDB should pay particular attention to ensure the DMF is designed with technical inputs from the concerned sector experts. In addition, NDB should ensure that the PIA nominates a dedicated staff for M&E to generate regular and reliable data and information. The Bank should ensure more staff continuity during implementation.

**Recommendation 5:** *Developing knowledge products based on projects to facilitate scaling up.*

127. By consolidating experiences and good practices generated from the projects, IEO recommends that NDB prepare knowledge products to record and showcase the successful experience of NDB-financed projects. The knowledge products should be disseminated to a wider audience to share successful experiences of the projects being designed and implemented in the unique context of NDB. This would be particularly useful for BRICS and other emerging markets and developing countries to learn, especially in the design and implementation of similar projects. It would also contribute to strengthening NDB's visibility and brand. In order to properly operationalize this recommendation, design reports should include dedicated provisions for knowledge management activities.

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# ANNEXES

**The annexes to the report (listed below) are available on the Independent Evaluation Office website at: [https://www.ndb.int/wp-content/uploads/2024/02/China-Luoyang-Metro-Project-Evaluation\\_Annexes.pdf](https://www.ndb.int/wp-content/uploads/2024/02/China-Luoyang-Metro-Project-Evaluation_Annexes.pdf)**

Annex 1: Peer review of Asia-Pacific Finance and Development Institute

Annex 2: Project area map

Annex 3: Project data

Annex 4: Definition and rating of the evaluation criteria used by IEO

Annex 5: Project design and monitoring framework

Annex 6: Evaluation framework

Annex 7: Innovative patents on energy saving

Annex 8: Energy efficiency aspects

Annex 9: CO<sub>2</sub> emissions reduced

Annex 10: Summary of customer satisfaction surveys

Annex 11: Trends in passenger traffic on LML1 and LML2

Annex 12: Annual key indicators of maintenance engineering department

Annex 13: Awards for Luoyang Metro Line 1 project

Annex 14: List of key persons met

Annex 15: List of documents reviewed

Annex 16: Photos from the evaluation main mission to luoyang





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