

# YAPAY ZEKÂ YÖNTEMLERİ KULLANILARAK KALKINMA YOLU PROJESİNİN BÖLGESEL ÜLKELER ÜZERİNDEKİ ETKİSİNİN MODELLENMESİ VE POTANSİYEL SONUÇLARI

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## ÖZET

Gelişim Yolu Projesi, Irak'ın altyapısını modernize etmeyi amaçlayan devasa bir girişimdir ve 2021 yılında başlatılmıştır. Bu proje, yeni Büyük Faw Limanı ile Türkiye sınırını birbirine bağlayan yaklaşık 1.200 kilometrelik bir ulaşım koridoru oluşturmayı hedeflemektedir. Proje, hem yüksek hızlı demiryolu hem de modern karayolu sistemlerini içeren çok modlu bir taşıma ağı ile bölgesel ticaretin yeniden şekillenmesine katkı sağlamayı amaçlamaktadır. Yolcu taşımacılığında saatte 300 km'ye kadar ulaşan hızlara sahip trenlerin yanı sıra, yük taşımacılığında da saatte 120 km hızla işlem görecektir. Bir sistemin entegrasyonu, Irak'ın küresel ticaret yollarındaki konumunu güçlendirecektir. 2023 yılı itibarıyla projenin fizibilite çalışmaları ve ön tasarım aşamaları tamamlanmış, demiryolu ve karayolu güzergahları onaylanmıştır. Projenin 2029'a kadar tamamlanması beklenirken, bu süreçte 100.000 yeni iş imkanı yaratılması öngörülmektedir. Proje, Irak ekonomisinin çeşitlenmesine katkıda bulunarak sadece petrol ve gaz sektörüne olan bağımlılığı azaltmayı, inşaat, lojistik ve turizm gibi sektörleri canlandırmayı amaçlamaktadır. Aynı zamanda, projenin sürdürülebilir teknoloji ve çevre dostu inşaat tekniklerini kullanması, 21. yüzyılın büyük altyapı projeleri için yeni bir model teşkil etmektedir. Gelişim Yolu, Irak'ın sadece altyapısını değil, aynı zamanda bölgesel entegrasyonunu ve ekonomik kalkınmasını hızlandıracak önemli bir projedir.

**Anahtar kelimeler:** Altyapı Modernizasyonu, Bölgesel Entegrasyon, Demiryolu ve Karayolu Sistemleri, Gelişim Yolu Projesi, Sürdürülebilir Altyapı, Irak Ulaşımı

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# MODELING THE IMPACT OF THE DEVELOPMENT ROAD PROJECT ON REGIONAL COUNTRIES USING ARTIFICIAL INTELLIGENCE METHODS AND POTENTIAL OUTCOMES

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DEMİRAL AKBAR

## ABSTRACT

The Development Road project is a large-scale infrastructure initiative that aims to establish a multimodal transport corridor spanning 1,200 kilometers between Iraq's Grand Faw Port and the Turkish border. This project, initiated in 2021, is designed to modernize Iraq's transportation infrastructure, integrating advanced railway and highway systems to enhance the movement of passengers and goods across the region. With the railway designed to accommodate speeds of up to 300 km/h for passengers and 120 km/h for freight, and a highway network supporting high-speed traffic, the Development Road seeks to connect Iraq more effectively with global trade routes, particularly linking the Far East, Middle East, and Europe. As of September 2024, the project has progressed through critical pre-feasibility and feasibility phases, culminating in the selection of optimal routes. The preliminary design phase, which began in 2023, is currently addressing topographical and geotechnical challenges. Despite delays, particularly in the railway system, significant progress has been made, with projected completion expected by 2030. The project is expected to generate around 100,000 jobs during its construction phase, contributing to economic diversification by reducing Iraq's reliance on oil revenues. By fostering regional integration, the Development Road will serve as a key driver for economic growth, industrial development, and sustainable infrastructure, positioning Iraq as a central player in global trade and regional socio-economic progress.

**Keywords:** Development Road Project, Infrastructure Modernization, Iraq Transportation, Railway and Highway Systems, Regional Integration, Sustainable Infrastructure.

## 1. Introduction

Iraq is currently embarking on an ambitious journey with the "Development Road" project, which began on December 29, 2021, when the State Company of Iraqi Railways (IRR) awarded PEG INFRASTRUTTURA S.p.A. the consultancy services for this groundbreaking infrastructure initiative (PEG INFRASTRUTTURA, 2021). The project encompasses comprehensive pre-feasibility and feasibility studies, along with preliminary detailed designs for both railway and highway systems (Hanguin Ramadhani et al., 2022). The ultimate goal is creating a vital link between the new Grand Faw Port and the Turkish border, spanning an impressive distance of nearly 1,200 kilometers (Mehmet Alaca, Haydar Karaalp, 2023).

The Development Road is not just another infrastructure project; it represents a transformative vision for Iraq's future. By integrating a state-of-the-art railway system capable of transporting passengers at speeds up to 300 km/h and freight at 120 km/h, alongside a modern highway network, this multimodal corridor aims to revolutionize transportation in the region (ESCWA, 2018). The project's significance extends beyond Iraq's borders, promising to establish an efficient connection between the Far East, Middle East, and Europe (OECD, 2024).

As of August 3, 2023, the project has made significant strides. The final feasibility report, submitted on January 5, 2023, identified the optimal railway (RW-1) and highway (HW-B) alignments (PEG INFRASTRUTTURA, 2021). These alignments received approval from the highest Iraqi authorities and IRR on March 30, 2023, paving the way for the next phase of development (Imad El-Anis, 2021).

The Development Road project is set to deliver a multitude of benefits, positioning Iraq as a key player in global trade and regional development (World Bank Group, 2022). At its core, the project is establishing a modern multimodal transport system that, in conjunction with the new Al Faw Grand Port, is creating a potential link between Far Eastern and European countries (UN ESCWA, 2018). This ambitious initiative actively diversifies Iraq's economic sectors beyond oil and gas, fostering growth in industries such as trading, construction, logistics, and tourism (Iraq National Development Plan, 2022). By doing so, it works toward stabilizing Iraq's GDP, making it less dependent on oil and gas revenues, which is particularly significant given the global trend towards renewable energies and efforts to mitigate climate change (World Bank Group, 2022).

As the project progresses, it alleviates traffic congestion and pollution, thereby improving health and safety conditions for Iraqi citizens (OECD, 2024). The

modernization of Iraq's railway and highway networks aligns with the country's socio-economic development goals, ushering in a new era of infrastructure. Importantly, the Development Road is generating substantial employment opportunities, with projections indicating the creation of approximately 100,000 new jobs between 2025 and 2029, thus boosting employment rates and improving living conditions across the nation (UN ESCWA, 2018).

Moreover, the project facilitates the free movement of passengers and freight among neighboring countries by implementing common rules and interoperability standards for rail systems. This not only enhances network efficiency and safety but also promotes regional integration (Imad El-Anis, 2021). On a broader scale, the Development Road fosters socio-economic development throughout the Middle East, encouraging the integration of diverse populations and cultures. In doing so, it aims to strengthen the stabilization process in the region, drawing parallels to the unifying effect of infrastructure development in Europe's history (OECD, 2024).

By connecting Iraq to the world through this transformative infrastructure project, the Development Road is paving the way for a new era of prosperity, cooperation, and sustainable growth. Its impacts are expected to resonate not only within Iraq but across the entire Middle East region, marking a significant step toward a more interconnected and prosperous future (World Bank Group, 2022). As the project continues to unfold, it stands as a testament to Iraq's commitment to modernization and its vision for a brighter, more connected tomorrow.

## 2. Project Progress and Detailed Analysis

The Development Road project is making significant strides, progressing through a series of meticulously planned phases that are propelling Iraq towards a future of enhanced connectivity and economic prosperity. As of September 2024, the project is well into its implementation stages, having successfully navigated through the crucial early phases that laid the groundwork for this monumental undertaking.

The journey began in June 2022 with the pre-feasibility phase, where experts diligently collected and analyzed documents and data, conducting preliminary traffic analyses to establish key assumptions. This foundational work quickly transitioned into the feasibility phase, spanning from July to December 2022. During this period, the team rigorously evaluated technical alternatives and conducted comprehensive traffic studies, culminating in a detailed cost-benefit analysis that informed the selection of the optimal railway routing and highway corridor. This thorough approach ensures that

the Development Road is not just ambitious in scale, but also economically viable and strategically positioned to maximize its impact on Iraq's infrastructure and economy.

Currently, the project is in the midst of its preliminary design phase, a critical juncture that began in April 2023 for the railway component and August 2023 for the highway system. This phase, set to conclude in March 2024 and July 2024 respectively, is incorporating extensive topographical and geotechnical investigations. The parallel development of both railway and highway systems is a testament to the project's comprehensive approach to transforming Iraq's transportation infrastructure. By simultaneously advancing both components, the Development Road is poised to create a truly integrated transport network that will revolutionize the movement of people and goods across the country.

As the preliminary design phase progresses, the project team is already looking ahead to the next stages. The upcoming functional lots and procurement strategy prioritization phase will be crucial in breaking down this massive undertaking into manageable, strategic segments. This approach not only facilitates more efficient construction but also allows for the prioritization of key sections that can deliver early benefits to the Iraqi people and economy.

Following this, the detail design phase is scheduled to commence in May 2024 for the railway and September 2024 for the highway, each lasting 12 months. This phase will bring the Development Road from concept to concrete plans, setting the stage for the physical realization of this visionary project. The meticulous attention to detail during this phase will ensure that every aspect of the Development Road meets the highest standards of safety, efficiency, and sustainability.

The project's timeline culminates with the tendering process for functional lots, leading into the construction and commissioning phase set to span from 2025 to 2029. This five-year period will see the physical manifestation of years of planning and design, transforming Iraq's landscape and connecting it more closely with the global economy. The inclusion of rolling stock requisitioning and procurement in this phase underscores the comprehensive nature of the project, ensuring that Iraq will have not just the infrastructure, but also the necessary equipment to fully operationalize this new transport corridor.

The Development Road's progress is a powerful statement of Iraq's commitment to its future. By creating a multimodal transport system that spans nearly 1,200 kilometers, connecting the new Grand Faw Port to the Turkish border, Iraq is positioning itself as a crucial link in global trade

routes. This project is not merely about building railways and highways; it's about constructing the foundations for economic diversification, job creation, and regional integration.

### **3. Integration of Artificial Intelligence in Infrastructure Development:**

The implementation of artificial intelligence (AI) in large-scale infrastructure projects has gained significant attention in recent years. AI-driven tools and methodologies offer transformative potential in optimizing design, execution, and long-term management. In the context of the Development Road project, integrating AI into transportation planning and construction processes can deliver increased efficiency and adaptability. A review of recent studies highlights several applications of AI that are directly relevant to the goals of this initiative:

#### **3.1. AI in Transportation Network Optimization**

AI has been effectively used to optimize transportation networks by modeling traffic flows and predicting demand under varying conditions. For instance, neural networks and reinforcement learning have been applied to analyze regional traffic congestion patterns, offering adaptive traffic management solutions. Such methodologies are pivotal in projects like the Development Road, where seamless integration of rail and highway systems is critical for minimizing delays and maximizing capacity utilization.

#### **3.2. Predictive Modeling for Economic Impacts**

Infrastructure development projects significantly influence regional and national economies. Studies utilizing machine learning models have demonstrated the ability to forecast economic outcomes by analyzing variables such as population growth, trade volumes, and regional connectivity indices. These insights can guide policy decisions, ensuring that projects align with long-term economic diversification goals, as envisioned in the Development Road initiative.

#### **3.3. AI in Smart Port Logistics Management**

Smart port systems use AI to optimize the flow of goods and resources. For instance, predictive analytics and Internet of Things (IoT) technologies can be employed to enhance cargo handling efficiency and reduce dwell times at ports. These practices directly align with the Development Road's integration with the Grand Faw Port, supporting Iraq's ambition to become a regional trade hub.

### 3.4. Machine Learning Applications in Infrastructure Sustainability

Recent studies have explored how machine learning can predict the environmental impact of construction activities and suggest sustainable alternatives. For example, AI algorithms can be used to select materials with lower carbon footprints and optimize energy consumption during operations. Adopting such approaches within the Development Road project can align with its sustainability goals.

By incorporating AI in areas such as traffic demand modeling, economic impact analysis, and sustainability planning, the Development Road can serve as a model for next-generation infrastructure development. Future work can focus on the creation of an AI-integrated management system to oversee project phases and ensure long-term operational efficiency.

As each phase unfolds, the Development Road is catalyzing transformation across multiple sectors. The project is attracting international attention and investment, spurring the development of new industrial zones, logistics hubs, and urban centers along its route. It's estimated that the construction phase alone will generate approximately 100,000 jobs, providing a significant boost to Iraq's economy and offering new opportunities for its workforce.

Moreover, the project's emphasis on using cutting-edge technology and sustainable practices in its design and construction is setting new standards for infrastructure development in the region. From advanced traffic management systems to environmentally friendly construction techniques, the Development Road is becoming a model for how large-scale infrastructure projects can be executed in the 21st century.

As Iraq continues to make steady progress on the Development Road, the project stands as a testament to the country's resilience, ambition, and vision for the future. It's not just building a road; it's paving the way for a new era of prosperity, connectivity, and opportunity for Iraq and the entire region.

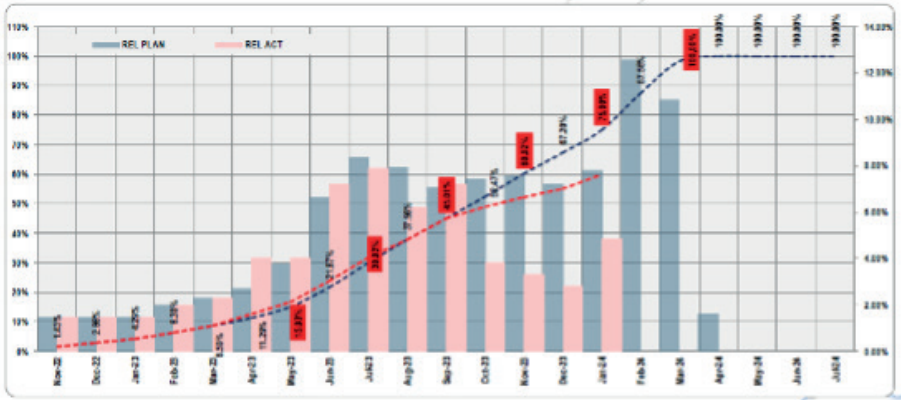


Figure 1: Railway Progress "Preliminary Design" (PEG INFRASTRUTTURA S.p.A.)

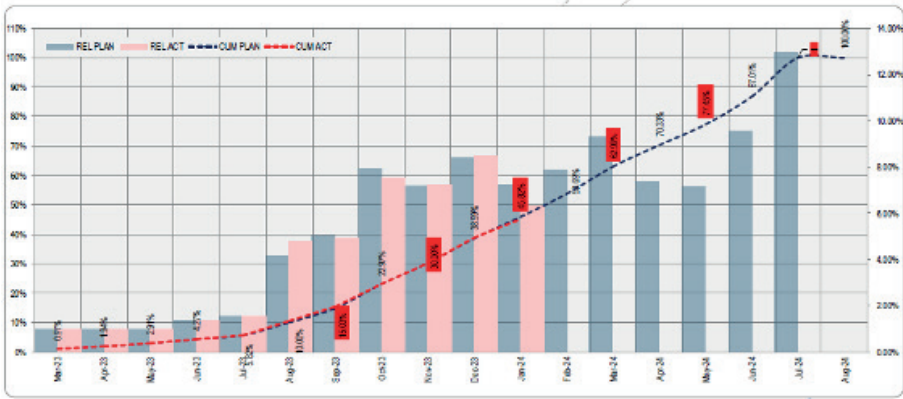


Figure 2: Highway Progress "Preliminary Design" (PEG INFRASTRUTTURA S.p.A.)

The Development Road project, a cornerstone of Iraq's infrastructure modernization, is currently navigating through its critical preliminary design phase, with both its railway and highway components showing significant progress despite facing distinct challenges. As of January 31, 2024, the railway component has achieved 75.40% completion against a planned 92.79%, while the highway stands at 59.67% compared to its 71.84% target. These figures, while indicating delays, underscore the project's ambitious scope and the complexity of its implementation.

The railway's journey, which began in November 2022, has been marked by a steeper progress curve, reflecting higher initial expectations and a more aggressive timeline. This ambition is evident in its planned S-curve, which outpaces that of the highway. However, this rapid trajectory has also led to more pronounced fluctuations between planned and actual



progress, particularly noticeable from July 2023 onwards. The railway team has encountered unforeseen site hindrances and impediments, primarily affecting topographical and geotechnical surveys. These challenges have necessitated a request for a minimum three-month extension, highlighting the project's adaptability in the face of real-world complexities.

In contrast, the highway component, which commenced later in March 2023, has demonstrated a more measured pace. Its flatter S-curve suggests a more conservative planning approach, which has resulted in smaller deviations from the planned progress. While still behind schedule, the highway's consistent performance indicates a potentially more realistic initial assessment of the challenges involved in such a massive undertaking.

Looking ahead, the project's trajectory from 2025 to 2030 promises to be a period of intensive development and gradual realization of its transformative potential. The railway, despite its current 17.39% lag, is expected to see accelerated efforts to close this gap. The requested three-month extension may push some milestones into early 2025, but the team's demonstrated ability to make rapid progress suggests that major construction could still complete by 2029, with commissioning activities extending into 2030.

The highway, currently 12.17% behind schedule, is likely to maintain its steady pace. This consistency, while slower, may result in fewer complications during the construction phase. Projections indicate that major highway works could be completed by 2030, with final integrations potentially extending slightly beyond this timeframe.

As both components advance, the years 2027-2028 will likely see an increased focus on integration points between the railway and highway systems. This period will be crucial for developing intermodal connections and shared infrastructure, setting the stage for a truly cohesive transportation network. By 2028, we may witness the partial operation of completed sections, marking the beginning of tangible economic benefits from the project.

The final stretch from 2029 to 2030 is expected to be a period of rapid increase in economic activity along the Development Road corridor. As more sections come online, the project will begin to fulfill its promise of transforming Iraq's economic landscape. The railway's more aggressive initial planning suggests a push to complete major construction by 2029, potentially leading the way in delivering these benefits.

Despite the current delays, with the railway at 75.40% and the highway at 59.67% completion of their preliminary design phases, the Development Road project remains on track to significantly reshape Iraq's infrastructure

and economy by 2030. The coming years will demand effective management of current setbacks, seamless coordination between railway and highway development, and agile responses to unforeseen challenges. However, the progress made thus far, coupled with the clear commitment to the project's vision, provides strong grounds for optimism.

As Iraq continues to build this ambitious multimodal transport system, spanning nearly 1,200 kilometers from the new Grand Faw Port to the Turkish border, each milestone achieved brings the nation closer to its goal of becoming a crucial link in global trade routes. The Development Road is not just about constructing railways and highways; it's about laying the foundation for economic diversification, creating thousands of jobs, and fostering regional integration. With its emphasis on cutting-edge technology and sustainable practices, this project is setting new standards for infrastructure development in the 21st century, promising to usher in a new era of prosperity and opportunity for Iraq and the entire region.

#### TRAFFIC STUDIES & TRAFFIC DEMAND

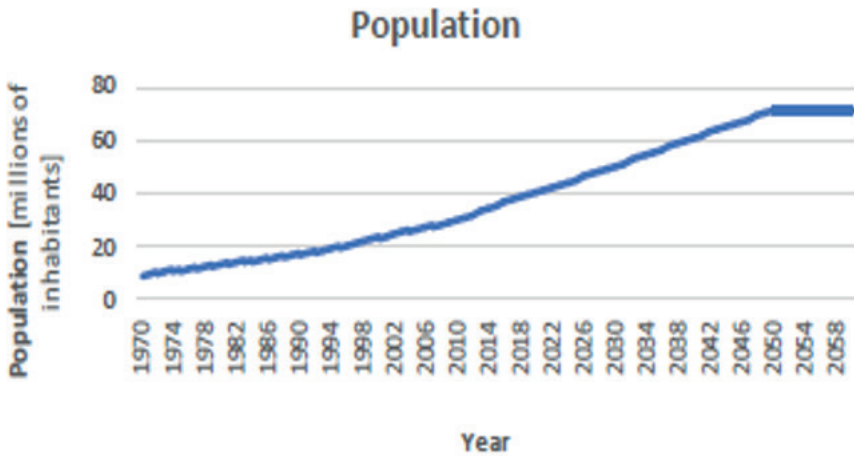


Figure 3: Iraqi population is supposed to continue to grow until 2050.

Based on the population growth graph provided for Iraq, as in Fig.3, we can analyze potential traffic demands for the Development Road project. The population is projected to increase steadily until 2050, reaching about 70 million from the current approximately 40 million. This suggests a continuous rise in potential users of the new infrastructure, likely leading to increasing traffic demand year-over-year. A corresponding growth in both passenger and freight traffic is expected, as more people will require transportation and consume goods.

After 2050, the population is expected to stabilize, indicating that traffic growth purely based on population increase may plateau. However, this doesn't necessarily mean traffic demand will stop growing, as other factors such as economic development and changing travel patterns could continue to influence demand. The infrastructure should be designed to accommodate the peak population projected for 2050 and beyond, with a phased development approach that gradually increases capacity to match the growing population and demand.

Population growth often correlates with economic growth, which could lead to increased freight traffic and business-related travel along the corridor. As the economy develops, shifts in the types of goods transported may occur, potentially affecting the balance between passenger and freight traffic. Population growth may also drive increased urbanization, potentially concentrating more people in cities connected by the Development Road. This urbanization could result in higher inter-city traffic and commuter flows.

As population and congestion increase, there may be a shift in preference toward rail transport for both passengers and freight, especially over longer distances. The highway component may see more growth in short to medium-distance traffic and last-mile connectivity. Capacity utilization of the infrastructure is expected to increase steadily until 2050, with the focus after 2050 potentially shifting from expansion to optimization and maintenance of existing infrastructure.

With a growing population, there could be increased emphasis on sustainable transportation options, potentially favoring rail over highways for certain journeys. Advancements in transportation technology over this period might also affect how the growing population uses the infrastructure, potentially altering traffic patterns and efficiency.

To refine this analysis, additional data such as projected economic growth rates, expected changes in trade patterns, regional development plans along the corridor, and anticipated shifts in energy use and environmental policies would be beneficial. This population projection provides a solid foundation for estimating future traffic demands, suggesting a period of steady growth followed by stabilization. It underscores the long-term value of the Development Road project in meeting Iraq's evolving transportation needs.

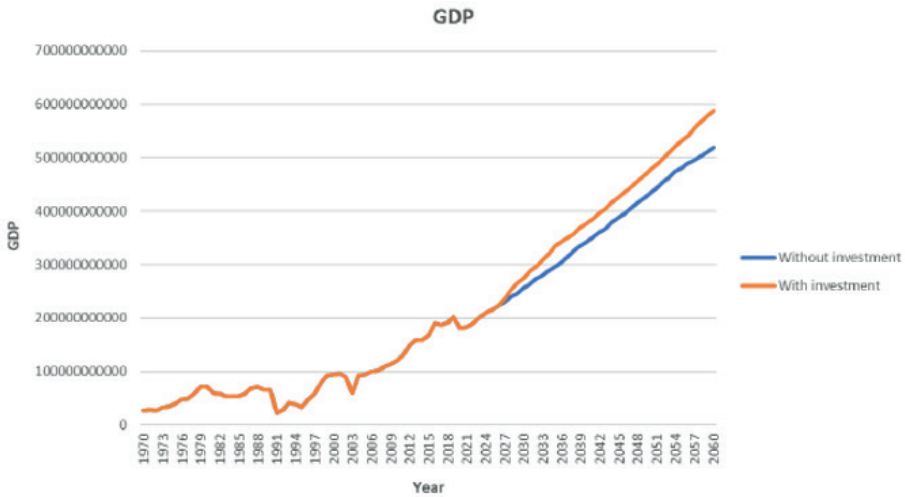


Figure 4: Iraq's GDP growth over time

The Fig. 4 illustrates Iraq's GDP growth over time, comparing two scenarios: one without investment and one with investment. The blue line represents GDP growth without investment, showing a steady upward trend, while the orange line represents GDP growth with investment, indicating that investment leads to a more accelerated growth rate starting around 2025 and continuing onward. Initially, both scenarios demonstrate similar GDP growth until around 2025, implying that the economy will grow steadily without immediate large investments. This steady increase might be due to the current economic structure and baseline activities. However, from 2025 onward, the GDP curve with investment starts to diverge from the no-investment scenario, showing a more rapid increase. This suggests that strategic investments, potentially in sectors like infrastructure, technology, or energy, could significantly enhance GDP growth. By 2050, the gap between the two scenarios widens considerably, highlighting that long-term investments could result in exponentially higher economic returns. Such investments could boost industrial productivity, job creation, and trade opportunities, leading to improved living standards, infrastructure, and overall national wealth. Moreover, the consistent increase in GDP with investment emphasizes the importance of continuous capital inflows and projects for sustained long-term growth. Ultimately, the graph underscores the crucial role of investments in driving Iraq's economic future, showing that without investment, growth will continue but at a much slower rate, while with investment, the country could experience far greater economic success.

Looking ahead to 2030, the two scenarios (with and without investment) are expected to have noticeably diverged, with the investment scenario showing higher GDP growth. By then, the positive impact of investments made around 2025 will likely start materializing, leading to tangible benefits such as enhanced industrial productivity, higher employment rates, and improved trade balances. The combination of strategic investments and a growing population will contribute to stronger consumer demand for goods, services, and infrastructure. This growth could also drive further economic diversification, potentially reducing Iraq's dependence on oil revenues as other sectors like manufacturing, agriculture, and services expand. With its strategic location, Iraq could strengthen its position in regional trade, especially if transportation infrastructure (like the Development Road) is improved, enhancing trade routes and attracting international business. However, while 2030 may bring significant economic progress, challenges like political instability, corruption, and security risks could still impede Iraq's ability to fully capitalize on these investments. Addressing these issues will be crucial to ensuring the full realization of the optimistic investment-driven GDP growth trajectory, helping Iraq to cement its economic future.

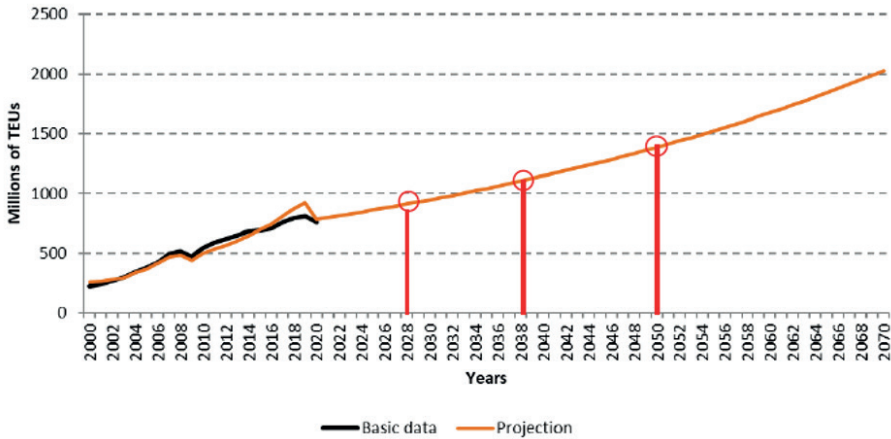


Figure 5: The growth of the world container port traffic

The fig.5 illustrates the projected growth of global container port traffic, measured in millions of TEUs (20-foot equivalent units), from 2000 to 2070. Historical data up to around 2020 is represented by the black line, showing consistent growth despite some fluctuations, likely caused by global economic events such as the 2008 financial crisis and market disruptions in 2016. The orange line represents future projections based on a double-logarithmic scale, indicating a smooth and continuous increase in container port traffic.

This suggests that global trade is expected to expand steadily in the coming decades. Key milestones highlighted in the chart include projections for 2028, 2038, and 2050. By 2028, global container traffic is expected to reach 912 million TEUs, rising to 1,103 million TEUs in 2038 and 1,387 million TEUs by 2050. The double-logarithmic projection indicates stable growth rather than exponential increases, suggesting that while global trade will continue to grow, the rate of growth may gradually decelerate as markets mature and technological advancements improve logistics efficiency. This steady rise in container traffic points to ongoing globalization and economic development, with more goods being traded internationally. Ports and logistics infrastructure will need to expand and adapt to meet this growing demand, emphasizing the importance of investments in capacity, technology, and operational efficiency. However, challenges such as geopolitical instability, environmental concerns, supply chain disruptions, and evolving trade policies could affect these projections. Sustainability and reducing carbon emissions will also be critical as container traffic increases. Overall, the figure presents an optimistic outlook for global container port traffic, projecting stable growth over the next several decades, but achieving these outcomes will require significant infrastructure investments and a focus on sustainability.

SOCIO-ECONOMIC STUDIES (IRRs)

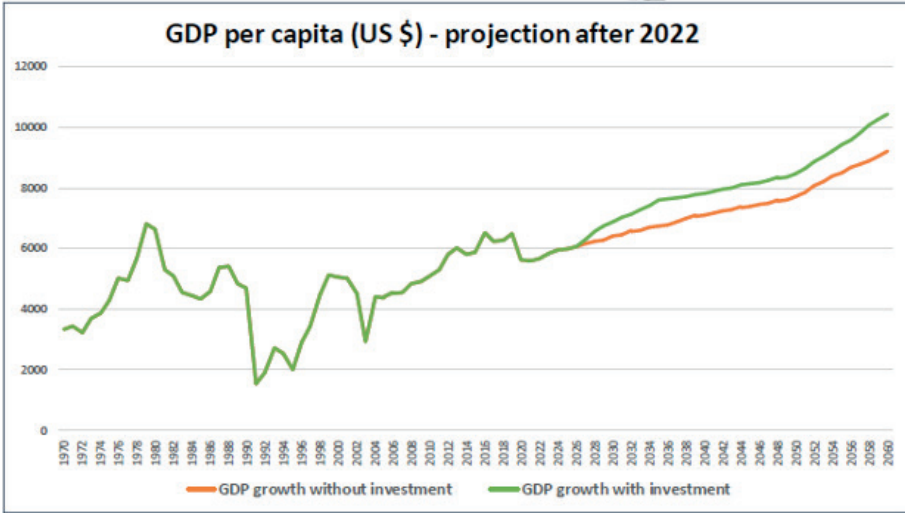


Figure 6: The projected GDP per capita (in US dollars) from 1970 to 2060

The Fig. 6 illustrates the projected GDP per capita (in US dollars) from 1970 to 2060, comparing two scenarios: one with investment (green line) and one without investment (orange line). Up until 2022, the graph displays significant fluctuations in GDP per capita, reflecting Iraq's economic instability due to

various factors such as political conflicts, oil price volatility, and regional crises. These fluctuations include multiple sharp declines and recoveries, highlighting the nation's economic vulnerability to external shocks.

After 2022, the forecast shows two distinct trajectories for GDP per capita growth—one with investment and one without. Both projections indicate a positive upward trend, but the investment scenario (green line) demonstrates a much steeper and sustained growth compared to the no-investment scenario (orange line). This suggests that strategic investments will have a profound positive impact on Iraq's economic development. The green line shows that by the mid-2030s, the effects of investment begin to significantly outpace the no-investment scenario, with a widening gap over the following decades. By 2060, the GDP per capita in the investment scenario is projected to reach approximately \$10,000, compared to about \$7,000 in the no-investment scenario. This indicates that investment could result in an approximately 40-50% higher GDP per capita by 2060, underscoring its critical role in enhancing economic prosperity.

The figure suggests that without investment, Iraq's GDP per capita will continue to grow but at a much slower pace. Investment, however, provides a clear long-term boost, likely due to improvements in infrastructure, technology, education, and industrial diversification. These factors contribute to more sustainable economic growth, higher productivity, and better living standards for the population. The green projection line demonstrates a relatively smooth and steady increase, indicating that investments may also bring greater stability to Iraq's economy. By fostering a more resilient economic base and reducing dependence on volatile sectors like oil, the country can achieve more consistent growth over time.

Moreover, this model implies that investments will not only lead to short-term gains but could also help Iraq diversify its economy. Moving away from a reliance on oil exports, investments could support a more balanced economic structure involving various sectors such as manufacturing, services, and technology. This diversification is crucial for maintaining the positive growth seen in the investment scenario. In conclusion, the figure highlights the substantial economic impact that investments could have on Iraq's GDP per capita. The investment scenario shows much stronger growth, leading to significantly higher income levels by 2060. This underscores the importance of long-term investment strategies for boosting economic performance, enhancing living standards, and creating a more resilient and diversified economy in Iraq.

## 5. Conclusion

The Development Road project is advancing steadily, with significant progress made in both the railway and highway systems. Following a detailed pre-feasibility and feasibility phase, the project has entered the critical preliminary design stage, with topographical and geotechnical investigations playing a key role. Despite facing delays, such as the railway's current 17.39% lag due to unforeseen site challenges, the project remains on track to deliver transformative infrastructure by 2030. As the project moves through the detailed design and construction phases, Iraq's goal of establishing a multimodal transport system linking the Grand Faw Port to the Turkish border is becoming increasingly tangible.

This ambitious initiative is not just about physical connectivity; it is set to catalyze economic diversification, job creation, and regional integration. With its emphasis on sustainability and cutting-edge technology, the Development Road project is poised to set new standards in infrastructure development. While challenges such as delays in construction and site complexities persist, Iraq's commitment to the project's vision of economic growth, regional collaboration, and enhanced global trade routes underscores the long-term potential of this initiative. The project's success will be instrumental in positioning Iraq as a central player in the global trade network, ultimately driving socio-economic progress across the region.

The adoption of artificial intelligence (AI) in the Development Road project presents numerous opportunities to enhance efficiency, sustainability, and scalability. Looking ahead, there are several areas where AI can drive significant improvements in infrastructure management and development. AI-powered systems can analyze real-time data from transportation networks, identifying congestion patterns and recommending alternative routes. This dynamic approach could significantly reduce delays and improve network efficiency. Predictive algorithms, supported by data from embedded sensors, can assess the condition of critical infrastructure components. This approach would enable early intervention to prevent failures, extending the lifespan of railways and highways. Additionally, AI can optimize the use of renewable energy sources, such as solar and wind power, in transport systems. Smart energy distribution models can efficiently allocate resources to power electrified railways and charging stations for electric vehicles.

The technological advancements pioneered in the Development Road project can serve as a blueprint for other regional infrastructure initiatives, such as cross-border trade corridors in Central and Southeast Asia. AI's capacity to harmonize operational standards across borders can strengthen



economic ties, enabling smoother movement of goods and people. For example, unified logistics platforms powered by AI could streamline supply chains across multiple countries. By successfully leveraging AI technologies, Iraq's Development Road can inspire similar modernization efforts worldwide, improving trade logistics and competitiveness for developing nations.

Through AI, construction processes can be optimized to reduce waste, minimize material usage, and mitigate environmental harm. Predictive systems can recommend sustainable practices tailored to specific sites. AI applications can also identify areas for energy savings in operational systems, such as optimizing rail schedules to reduce fuel consumption. Integration with green technologies, like renewable power grids, can further enhance sustainability. Moreover, AI tools can model long-term environmental impacts on infrastructure, helping to develop resilient designs capable of withstanding extreme weather and other climate-related challenges.

The Development Road project provides a unique case study for exploring the intersection of AI and infrastructure growth. Areas for further research include scaling AI technologies to similar projects in other countries, addressing the ethical implications of AI in public infrastructure, and crafting policies that ensure equitable and secure use of AI systems. The transformative potential of AI in infrastructure projects cannot be overstated. By incorporating these technologies, the Development Road can achieve greater efficiency, reduced environmental impacts, and enhanced economic outcomes. Furthermore, Iraq's success in implementing AI-driven strategies may serve as an example for other nations, setting a global standard for modern infrastructure development.

## REFERENCES

Hanguin Ramadhani et al. (2022), Transportation Sector in Iraq: Roads & Railways Scene Overview, KAPİTA, <https://kapita.iq/storage/app/media/New%20Research%20Publications/Reports/Transportation%20Report%20Roads%20and%20Railways%20Overview.pdf>

Imad El-Anis (2021). Transport Infrastructure and Regional Integration in the Middle East, *The Muslim World*, V.111, P. 1-139.

Iraq National Development Plan (2022). Iraq's Infrastructure Projects for Economic Diversification. <https://mop.gov.iq/en/archives/10024> and [www.iraq-jccme.jp/pdf/archives/nationaldevelopmentplan2018\\_2022.pdf](http://www.iraq-jccme.jp/pdf/archives/nationaldevelopmentplan2018_2022.pdf)

Mehmet Alaca, Haydar Karaalp (2023), <https://www.aa.com.tr/en/middle-east/turkiye-iraq-development-road-project-enhancing-regional-connectivity-trade/2993555#> )

OECD/ILO/UNDP (2024), Informality and Structural Transformation in Egypt, Iraq and Jordan: A Framework for Assessing Policy Responses in the MENA Region, OECD Publishing, Paris, <https://doi.org/10.1787/efb16d0b-en>.

PEG INFRASTRUTTURE S.p.A. (2021). " THE DEVELOPMENT ROAD" [https://www.iraq-jccme.jp/pdfdownload.php?mode=dl&file=https://www.iraq-jccme.jp/pdf/business/220\(Attachment%201\)The%20Development%20Road%20Project%20Overview.pdf](https://www.iraq-jccme.jp/pdfdownload.php?mode=dl&file=https://www.iraq-jccme.jp/pdf/business/220(Attachment%201)The%20Development%20Road%20Project%20Overview.pdf)

UN ESCWA (2018). Economic Impact of Transportation Infrastructure in Iraq. <https://www.unescwa.org/events/supporting-establishment-national-centre-sustainable-transport>

World Bank Group (2022). Infrastructure Development in Iraq: A Strategic Approach. <https://www.worldbank.org/en/country/iraq/overview>