# Final report

## 1. Project details

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| **Project title** | DBD 2020-II Blockshipping AI Import Container Dwelltime Prediction (AI-IDP) |
| **File no.** | J.nr. DBD-00008 |
| **Name of the funding scheme** | EUDP særpulje til "Grøn omstilling af Det Blå Danmark" |
| **Project managing company / institution** | Blockshipping A/S |
| **CVR number** (central business register) | 3835 3861 |
| **Project partners** | 2021.ai ApS<br>Mindsoft Aps |
| **Submission date** | 08 June 2023 |

## 2. Summary

With this project, AI-IDP (Artificial Intelligence - Import Dwelltime Prediction), Blockshipping has applied sophisticated artificial intelligence and machine learning techniques to optimize the operation of ocean container terminals.

A "narrow" AI/ML approach has been used, where one specific pain point has been identified and a Use Case, and eventually an AI/ML model has been developed and put in production, to alleviate this pain point.

Through Blockshipping's AI-IDP product, container terminals will realize substantial reductions in energy consumption and CO2 emissions, as well as significant monetary savings.

Med dette projekt, AI-IDP (Artificial Intelligence - Import Dwelltime Prediction), anvender Blockshipping sofistikeret 'artificial intelligence' og 'machine learning' til optimering af operationen på ocean container terminaler.

En "smal" AI/ML tilgang er blevet brugt, hvor et specifikt smertepunkt er blevet identificeret, og en use case, og til sidst en AI/ML model er blevet udviklet og sat i produktion, for at lindre dette smertepunkt.

Gennem Blockshipping's AI-IDP produkt, vil container terminalerne opnå betydelige reduktioner i energiforbrug og CO2 udledning, samt opnå betydelige økonomiske besparelser.

# 3. Project objectives

Blockshipping's AI-IDP is addressing a problem (an inefficiency) that has been inherent in the container terminal industry for decades.

There are approximately 1,000 container terminals globally, and for decades these terminals have been performing an excessive number of non-productive moves of containers in each terminal in order to serve the customers of the terminals.

By applying sophisticated artificial intelligence algorithms on import containers, it is possible to predict how long import containers will remain in the container terminal before being delivered to the importer. This enables intelligent stacking of import containers in the container terminal and thereby elimination of a very large part of these non-productive moves.

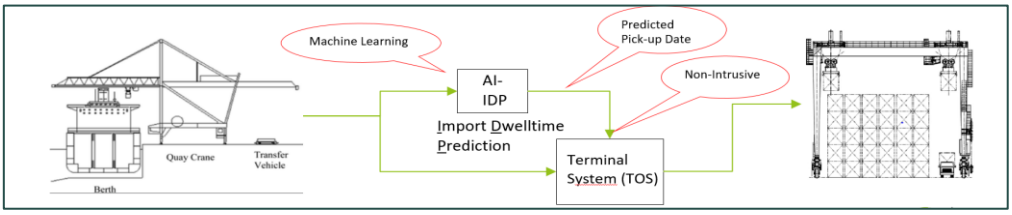
On a medium sized container terminal, this has a potential to eliminate 180,000 unnecessary container shuffle moves annually, resulting in a CO2 reduction of 2,400 tons CO2 and a monetary saving of close to 3 mill EUR annually (depending on local labor cost).

Some of the 1,000 terminals are smaller, some are larger. And in total there is a huge opportunity globally in improving efficiency in this, both in terms of CO2 reductions and monetary savings.

The usage of artificial intelligence in the operation of container terminals is still at its very infancy. Typically, the terminals have not had access to the required competences (e.g., data science, etc.) and they have typically not had the required IT infrastructure and management disciplines to succeed with AI.

Only recently with the rapid global maturing of the AI/ML disciplines, coupled with dramatic improvements to local infrastructure (incl. cloud computing and high-speed reliable data communication) is it becoming possible to apply these disciplines in the container terminal environment.

There is an opportunity now for reaping great efficiency benefits, and there is a window of opportunity for a commercial Danish export success in enabling terminals to reap these benefits.




No energy technology has been developed as such in the project, however, successful deployment of AI-IDP at medium size container terminals will result in a CO2 reduction of 2.400 tons annually.

# 4. Project implementation

The project was organized in 5 work packages involving two pilot customers, one based in the US and the other in Europe/Africa.

For the pilot customer 1 (Company1) based in the US the project involved integrating AI-IDP with the Terminal Operating System with the aim to prove that AI-IDP could be deployed in a real operational setting and generate business value.

For the Europe/Africa pilot customer (Company 2) the demonstration project involved a proof of business value workstream where the initial aim was to prove that AI-IDP based on two years historical data extracts was able to predict dwell time of import containers with reasonable accuracy.

For both pilot customers the target was to implement AI-IDP on the two container terminals and move the product into on-going live operation.

A key risk experienced in the project was project delays caused by the COVID-19 situation, which negatively affected progress of the project. The Omicron variant resulted in new restrictions on travel and physical meetings, which were necessary in the final phase of the project to complete implementation and integration.

Especially our pilot customer in North America (Company 1) was hit hard and their focus was changed to fire fighting and business continuity, instead of optimizing processes and workflows. The US customer, which was expected to be completed in June 2022, unfortunately were not able to move forward with the project at all.

In lieu of the US customer Blockshipping was able to secure an alternative customer in Spain involving completion of a Proof of Business Value (PoBV), followed by integration and implementation of AI-IDP in production at their very large terminal in Spain.

The “Company 2” Europe/Africa pilot customer is a large global terminal operator with many different projects and with such large clients there are inherent risks that project portfolio reviews temporarily may deprioritise projects. They too were hit by the effects of the COVID-19 restrictions and shut-downs, with significant delays to the project consequently. The progress with the customer ("Company 2") unfortunately saw further delays due to reprioritization and the project in Europe/Africa is expected to be ready for integration only during 4$^{th}$ quarter 2022.

- *Did the project implementation develop as foreseen and according to milestones agreed upon?*

The project was significantly delayed owing to the COVID-19 situation which negatively affected progress of the project. Especially our pilot customer in North America (Company 1) was hit hard and their focus was changed to fire fighting and business continuity instead of optimizing processes and workflows. The US customer, which was expected to be completed in June 2022, unfortunately were not able to move forward with the project at all.

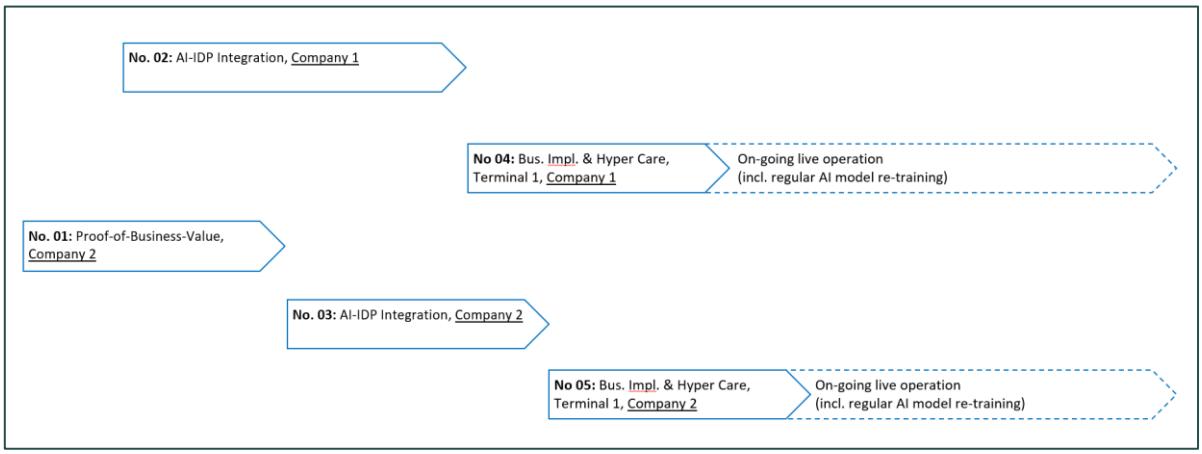
In lieu of the US customer Blockshipping was able to secure an alternative customer in Spain involving completion of a Proof of Business Value (PoBV), followed by integration and implementation of AI-IDP in production at their very large terminal in Spain.

Based on the latest approved extension of the project until end September 2022, the project has been completed with implementation of AI-IDP at Company 1, Terminal 1.

The project experienced some unforeseen issues related to the migrating the AI/ML model from being developed based on two years' worth of historical data extracts to operating in production on operational live data feeds. Operational live data streams reflect recent dynamic changes and disruptions occurring in the global supply chain which is not prevalent in the historical data. This situation was mitigated by developing an afterburner module which can adjust the AI/ML model to reflect recent operational adverse events with the aim to achieve similar prediction accuracy as demonstrated in the Proof of business value pilot.

# 5. Project results

This section provides a summary of what was achieved for each work package:




| **Arbejdspakketitel** | Proof-of-Business-Value, Company 2 |
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| **Arbejdspakkenummer** | No. 01 |
| **Arbejdspakkens indhold og aktiviteter** | |
| • Receive one year of operational data from one container terminal<br>• Configure and calibrate the AI model<br>• Run the AI model on the one year of data<br>• Evaluate and report the results | |
| **Arbejdspakkeleverancer/-resultater** | |
| • Report that documents the result of the 'proof-of-business-value' | |
| **Tekniske og kommercielle milepæle** | |
| • Receive the data<br>• Complete the model run | |
| **Udstyr/eksterne leverancer** | |
| • AI model configured and calibrated, executed by partner 2021.AI | |
| **Results** | |
| Due to the circumstances mentioned in section 4 last paragraph the customer (Company 2) gave priority to other projects and the project was put on hold. It is only here in October 2022, after EUDP project completion, that the project has been commenced. Blockshipping has now had a new project kick off meeting with the customer and we expect to receive one year of operational | |

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| data in the week starting 24th October 2022. The customer has indicated that additional differentiating data elements will be included in the dataset which is positive, and which addresses one of our key learning points in the project. |

| **Arbejdspakketitel** | AI-IDP Integration, Company 1 |
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| **Arbejdspakkenummer** | No. 02 |
| **Arbejdspakkens indhold og aktiviteter** | |
| • (Proof-of-Business Value' for Company 1 has already been successfully completed before the start of this project)<br>• Define the systems architecture for integration between AI-IDP and the terminal's 'terminal operation system'<br>• Develop the required integration software<br>• Deploy the various components into the (previously defined) Cloud infrastructure for Company 1<br>• Test the full systems configuration on the first container terminal<br>• Define the ongoing support- and operations-structures | |
| **Arbejdspakkeleverancer/-resultater** | |
| • Developed, tested and deployed AI-IDP systems configuration, ready for live production<br>• Relevant test reports, systems-documentation, process documentation, etc. | |
| **Tekniske og kommercielle milepæle** | |
| • Complete the development of the systems configuration<br>• Complete test and deployment of the systems configuration | |
| **Results** | |
| Due to the Covid 19 situation the US customer unfortunately were not able to move forward with the project at all which was expected to be completed in June 2022. However, during the initial stages of engaging with the customer the terminal performed an independent assessment by an Operations Research specialist with the purpose of illustrating the benefits of deploying AI-IDP. Please see Appendix. | |

| **Arbejdspakketitel** | AI-IDP Integration, Company 2 |
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| **Arbejdspakkenummer** | No. 03 |
| **Arbejdspakkens indhold og aktiviteter** | |
| • Define the systems architecture for integration between AI-IDP and the terminal's 'terminal operation system', preferably by re-using the architecture defined for Company 1<br>• Configure the required integration software, based on version developed for Company 1<br>• Deploy the various components into the (previously defined) Cloud infrastructure for Company 2<br>• Test the full systems configuration on the first container terminal<br>• Define the ongoing support- and operations-structures | |
| **Arbejdspakkeleverancer/-resultater** | |
| • Developed, tested and deployed AI-IDP systems configuration, ready for live production<br>• Relevant test reports, systems-documentation, process documentation, etc. | |
| **Tekniske og kommercielle milepæle** | |
| • Complete the development of the systems configuration<br>• Complete test and deployment of the systems configuration | |
| **Results** | |

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| Ref comments made in WP01 above the integration is only expected to completed in Q1 2023. |

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| **Arbejdspakketitel** | Business Implementation & Hyper Care, Terminal 1, Company 1 |
| **Arbejdspakkenummer** | No. 04 |
| **Arbejdspakkens indhold og aktiviteter** | |
| • Implement AI-IDP (integrated as per Work Package 2) in live operation on the first container terminal for Company 1<br>• Provide extended 'hyper care' support- and operations-services for a duration of three months (to Terminal 1, Company 1) | |
| **Arbejdspakkeleverancer/-resultater** | |
| • AI-IDP provides the planned import dwell time predictions to Terminal 1, Company 1, for the business realization of the planned benefits<br>• Relevant follow-up KPI reporting and dashboard access | |
| **Tekniske og kommercielle milepæle** | |
| • AI-IDP live at Terminal 1, Company 1 | |
| **Results** | |
| In lieu of the US customer Blockshipping was able to secure an alternative customer in Spain involving completion of a Proof of Business Value (PoBV), followed by integration and implementation of AI-IDP in production at their very large terminal.<br>The current results of the PoBV and the implementation is that the AI model were developed and calibrated including integration to the BI environment of the Spanish terminal customer. During the running in period some issues related to partial missing data in the on-going data feed to the AI model were detected which is currently being fixed by the integration service company of the customer. After these issues have been fixed a retraining of the AI model will be performed whereafter the terminal will compare the results of the predictions with the actual results from live operation. | |

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| **Arbejdspakketitel** | Business Implementation & Hyper Care, Terminal 1, Company 2 |
| **Arbejdspakkenummer** | No. 05 |
| **Arbejdspakkens indhold og aktiviteter** | |
| • Implement AI-IDP (integrated as per Work Package 3) in live operation on the first container terminal for Company 2<br>• Provide extended 'hyper care' support- and operations-services for a duration of three months (to Terminal 1, Company 2) | |
| **Arbejdspakkeleverancer/-resultater** | |
| • AI-IDP provides the planned import dwell time predictions to Terminal 1, Company 2, for the business realization of the benefits | |

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| • Relevant follow-up KPI reporting and dashboard access |
| **Tekniske og kommercielle milepæle** |
| • AI-IDP live at Terminal 1, Company 2 |
| **Results** |
| Ref comments made in WP01 above the integration is only expected to complete in Q1 2023. |

Overall, despite the delays owing to the COVID-19 situation the original objectives of the project was achieved in that the AI-IDP product was implemented on a container terminal in Spain.

With regard to technological results the project did not produce any unexpected results, however, many valuable learning points was gained relating to how AI/ML models and solutions are deployed.

- A key learning from the project relates to how the AI model is being tested and verified to most accurately simulate how the AI will function in a real life production setting with real time operational data being continuously fed to AI-IDP.
- Another very important learning point is that even relatively minor changes in the number of and quality of data elements e.g. lack of “place of origin” or “final destination” had a bigger impact on prediction accuracies than anticipated which emphasized the need for more signals to be added to the AI model.

Regarding obtained commercial results the results achieved had a positive effect in our effort to secure additional container terminal customers, which is the exclusive target group for AI-IDP. At completion of the project, with the implementation of AI-IDP at the terminal in Spain, two additional large ocean container terminal have signed up for PoBV and implementation of the AI-IDP solution with a large number of additional terminals showing interest in AI-IDP and other AI/ML solutions.

# 6. Utilisation of project results

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| Describe how the obtained technological results will be utilised in the future and by whom. | The beneficiaries of the obtained technological results are ocean container terminals who will be able to enjoy a combination of three benefits depending on the layout, configuration and capacity utilization of the container terminal:<br>1. Reduced number of unnecessary shuffle moves in the yard, improved truck turn-around time at the gate complex and in the yard.<br>2. Improved capacity utilization of the terminal, which in some cases may defer huge CAPEX investments needed to expand the container terminal or allow for additional main lines to be handled by the terminal.<br>3. Reduction in CO2 emissions from improved usage of container handling equipment in the container terminal and reduction in truck idle time. |
| Describe how the obtained commercial results will be utilised in the future and by whom the results will be commercialised. | The benefits will be commercialised by Blockshipping A/S. |
| Did the project so far lead to increased turnover, exports, employment and additional private investments? Do the project partners expect that the project | The project has resulted in increased turnover because Blockshipping has secured two additional container terminals as customers. The project partners will likewise benefit from the increase in customers. |

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| results in increased turnover, exports, employment and additional private investments? | |
| Describe the competitive situation in the market you expect to enter.<br>Are there competing solutions on the market? Specify who the main competitors are and describe their solutions. | The competitive situation is characterized by around three to four competitors. All of these are focusing on large scale AI/ML implementations, which are both slow and costly to implement, compared to the AI/ML solutions from Blockshipping. Additionally, some of the Global Terminal Operator have plans and aspirations to introduce AI/ML through in-house projects. |
| Describe entry or sales barriers and how these are expected to be overcome. | Entry barriers are quite high in that only around 15% of AI/ML projects succeed in deploying their AI model successfully in production.<br>Sales barriers are significant as well, due to the extreme long sales cycles of the global terminal operator business segment.<br>The terminal industry is only slowly starting to consider exploration of AI/ML solutions to optimize the terminals and are reluctant to start large and costly AI/ML projects.<br>Blockshipping is focusing on “narrow” AI/ML solutions, that are relatively fast and inexpensive to build, train and implement. |
| How does the project results contribute to realise energy policy objectives? | Due to the reduced and more efficient usage of container handling equipment there is a marked reduction in CO2 emissions at those container terminals utilizing Blockshipping’s AI-IDP product. |

# 7. Project Conclusion and Perspective

Container Terminals globally are increasingly focusing on moving to green and clean energy solutions. This project proved that Blockshipping’s AI-IDP solution is a viable option to achieve not only reduced carbon emissions, but also operational savings, improved yard efficiencies and better capacity utilization of highly capital-intensive container terminal assets.

The project work produced results that will pave the way to implementing a viable solution to meet the goals of decarbonising the container terminal industry while bringing Danish shipping to the forefront of the push to find cleaner solutions while maintaining a strong maritime presence.

The next steps for our technology is that AI-IDP will be fully integrated into the Terminal Operating System of the Spanish customer moving from feeding predictions into their BI environment to being used in the live decking process of the terminal. In parallel Blockshipping has kicked off AI-IDP PoBV and Implementation project with a large container terminal on US East coast and a container gateway terminal in West Africa. For both these two customers the process of obtaining historical data extracts is under way.

A full deployment of AI-IDP at a medium size container terminal like the one in Spain, is expected to result in a CO2 reduction of 2.400 tons annually, as per the original project objectives

# Appendices

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Appendix I Projecting Yard shuffles When Using AI-IDP