Vacuum lift pilot to reduce physical workload in cargo break-down operations

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SUMMARY

This pilot study evaluated a vacuum lift system designed to reduce the physical workload of manual lifting at a cargo break-down workstation. Sensor data and user feedback showed that the device eliminated manual lifting and substantially reduced physical strain, though some ergonomic issues remain.

KEYWORDS

Physical Workload, Cargo Handling, Ergonomic Intervention

Introduction

Since 2021, comprehensive physical-workload assessments have been conducted within the Cargo Handling department. These assessments, carried out by the company's Safety & Compliance Organisation, identified the most physically demanding tasks across operational units, including the high volume of manual lifting inherent to cargo break-down activities. Reducing this workload is essential for compliance with statutory occupational-safety requirements and for improving working conditions for employees. In alignment with the company's broader ambition to integrate robotics and assistive technologies within its autonomous-operations programme, several lifting aids have been evaluated since 2023. This paper reports on a pilot study examining the effectiveness of using a vacuum lift.

Project Goal

The primary objective of the project was to reduce the physical workload associated with manual lifting during cargo break-down operations through the introduction of a vacuum lift. The study assessed the extent to which the device mitigated previously identified high-risk lifting tasks and evaluated its operational suitability in terms of user experience and processing time.

Research Questions

The study addressed the following questions:

- To what extent does the vacuum lift reduce physical workload arising from lifting?
- Does the device introduce any new safety or ergonomic risks?
- How do users perceive the device with regard to support and ease of use?
- What is the impact of the device on process speed?
- Is the device capable of handling all relevant cargo types (e.g., boxes and bags)?

Approach

A three-month pilot study was implemented at a single break-down workstation within the Build-Up & Break-Down unit of the Cargo Handling department. At these workstations, 10-ft and 20-ft plates loaded with boxes (e.g., mail, food and electronics) must be manually broken down and repalletised prior to further transport by forklift. The pilot was coordinated by a multidisciplinary working group consisting of a project manager, unit manager, employees, ergonomists and a company physiotherapist. Five operators participated voluntarily and received training from the lifting-aid supplier to ensure proficient use of the vacuum lift and to enable peer-to-peer training.

Methods

Objective measurements were conducted to evaluate physical workload and process speed. Motion-capture sensors recorded body posture and movement during load placement both with and without the lifting aid. These recordings were also used to determine processing time. Pushing and pulling forces were measured by an ergonomist using a professional force-measurement device. Two ergonomists conducted observational assessments to identify any emergent safety or ergonomic issues. User experience was assessed through a baseline questionnaire and a follow-up questionnaire administered five weeks later, completed by thirteen participants. Cargo suitability was evaluated by processing all cargo types that naturally occurred during the pilot period.

Results

The pilot demonstrated clear benefits in reducing physical workload, improving user experience and maintaining process efficiency for the majority of cargo types. Manual lifting was completely eliminated when the vacuum lift was used. Although pushing and pulling replaced lifting, the forces measured did not exceed acceptable ergonomic thresholds. However, an increase in dominant-arm elevation was observed.

Participants reported a substantial decrease in perceived workload. Most users reported that they enjoyed working with the device, felt safe during its operation and would recommend it to colleagues. Suggestions for improvement included larger or alternative suction cups, enhanced performance on less rigid boxes and the availability of a second device per workstation. Analysis of sensor-recording data indicated an increase in processing time of approximately 20% when using one vacuum lift device at the workstation. The vacuum lift was capable of handling approximately 80% of boxes processed during the pilot. It was unsuitable for wet boxes, damaged flower boxes and jute bags.

Key Takeaways and Recommendations

This pilot study demonstrates that assistive lifting technology can fully eliminate most manual lifting and substantially reduce high-risk ergonomic exposures in cargo-handling operations. Objective sensor data were critical for substantiating the benefits and identifying emerging risk patterns, such as increased upper-arm elevation. User acceptance was high, particularly when supported by structured training and on-site guidance. Although the initial impact on process speed was negative, operational efficiency may be improved through the deployment of two devices per workstation. As approximately 80% of cargo types can be handled by the vacuum lift, combining this technology with alternative strategies for atypical loads is advisable.

A structured follow-up pilot, incorporating two lifting devices, a broader range of suction cups and enhanced operator training, particularly to minimise unnecessary arm elevation, is recommended to finalise the business case for wider implementation of the lifting aid across all cargo break-down workstations (Raza Usmani et al., 2025).

References

Raza Usmani, A., Kim, S., Smets, M., Nussbaum, M.A. (2025). What drives the effective integration of lift assists in automotive assembly? Perspectives from operators, ergonomists, and manufacturers. *Applied Ergonomics, 133,* 104711.https://doi.org/10.1016/j.apergo.2025.104711