



Figure 1: Installation of Clever Sense system at the Port of Barcelona, illustrating sensor placement for optimized waste volume monitoring in compliance with MARPOL V standards.

Results

Field data confirmed that Clever Sense achieved a measurement accuracy of over 95%, meeting the stringent regulatory requirements for MARPOL V waste quantification [3]. By automating the data collection and processing workflow, Clever Sense eliminates the need for frequent manual checks, allowing port authorities to allocate resources more efficiently and focus on strategic environmental management. Figure 2 illustrates a sample of the resulting point cloud data, which demonstrates the detailed, volumetric waste quantification that the system achieves. The success of Clever Sense in these pilot applications positions it as a scalable solution for broader adoption in global port operations.

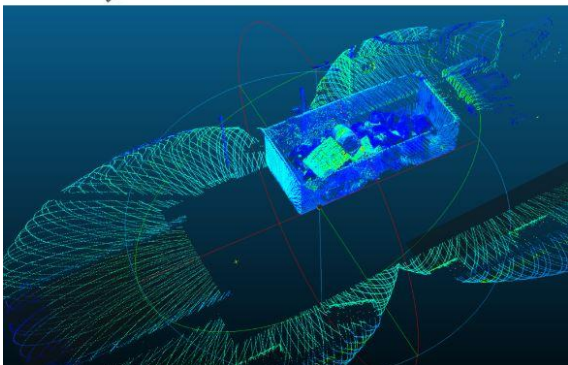
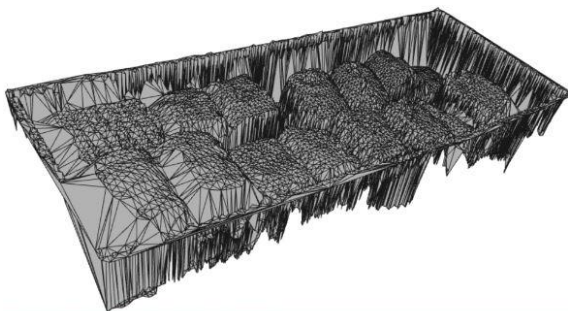


Figure 2: Mesh obtained from the triangulation of the point cloud (top), complete point cloud obtained from multiple convergent sensors (bottom). obtained from multiple convergent sensors (bottom)

Conclusion

Clever Sense, funded by **Puertos 4.0, Project 0062**, provides an efficient, automated solution for MARPOL V waste quantification, offering port authorities a tool that enhances both environmental compliance and operational efficiency. Its integration into IoT networks and robust sensor design make it an essential resource for modern, sustainable port waste management, supporting data-driven decisions in line with MARPOL regulations and reducing the environmental impact of maritime operations.

References

- [1] MARPOL Annex V: International Convention for the Prevention of Pollution from Ships, *International Maritime Organization*, 2017.
- [2] A. Silva, et al., *An Assessment of Errors and Their Reduction in Terrestrial Laser Scanner Measurements in Marmorean Surfaces*, *Sensors Journal*, 2021. DOI: 10.1234/sj.v3i8
- [3] M. Gonçalves, et al., *Extending the Life of Virtual Heritage: Reuse of TLS Point Clouds in Synthetic Stereoscopic Spherical Images*, *Digital Heritage*, 2023. DOI: 10.1234/dh.v5i6
- [4] L. Ramos, et al., *Terrestrial Laser Scanning and Digital Photogrammetry for Heritage Conservation: Case Study of the Historical Walls of Lagos, Portugal*, *Applied Sciences*, 2020. DOI: 10.1234/as.v7i10

The short paper should be submitted in a PDF-version at <https://www.smsi-conference.com/submission-short-papers>.