The impact of automation in hospital pharmaceutical logistics management: economic analysis in Europe

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RESEARCH & APPLICATIONS
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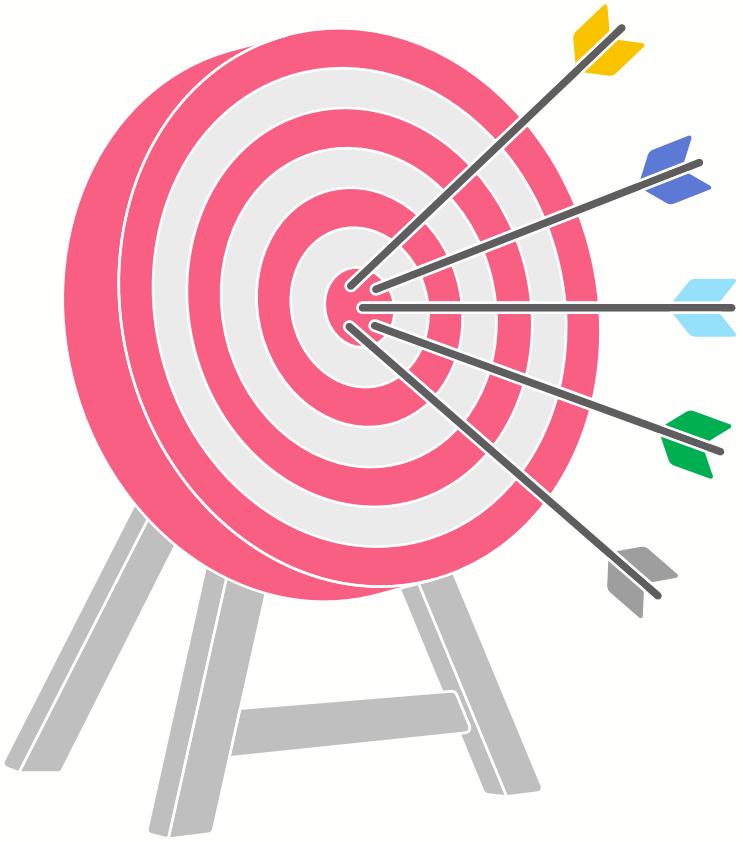
Automation in Europe

- In European hospitals, up to **0,1% of all doses are affected by medication errors,** leading to longer hospital stays and **higher costs**
- Studies prove that **automation reduces errors** by 50–100%, depending on the technology
- European healthcare systems are **increasingly adopting automation** and digital solutions to improve efficiency and safety in medication management,
- Despite this growing interest, adoption remains **limited due to high upfront costs** and the complexity of integrating new technologies into existing hospital infrastructures,
- A major barrier is the **lack of robust, large-scale economic evidence** demonstrating return on investment,
- The **EU Regulation** 2021/2282 on **Health Technology Assessment** (HTA), fully enforced as of January 2025, calls for **stronger economic data** to support **investment** decisions in health technologies,

Objective



Actionable Evidence

The study aimed to assess the economic and organizational impact of medication management automation across Europe,

Financial Sustainability

Assessed long-term investment viability

Standardized Hospital Model

Adopted a standardized hospital dimension for a comparison across Nations

27 EU Countries plus UK

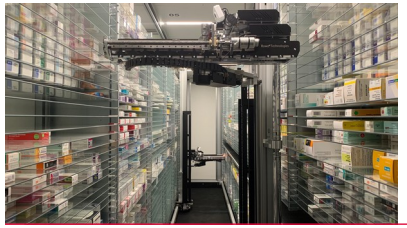
The analysis covered all **27 EU countries plus the UK**, using a standardized hospital model to ensure comparability,

Five Key Technologies

It evaluated **five key technologies** implemented in **acute care hospitals** over a **10-year period** (2024–2034),

The goal was to provide actionable evidence to hospital managers and policymakers on the long-term financial sustainability of these investments,

Technologies under assessment

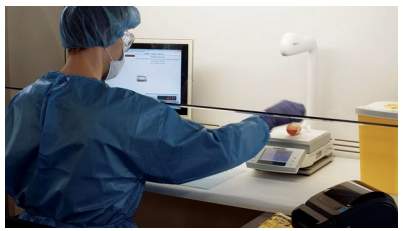


Inventory Robot – Automates storage and retrieval in the central pharmacy; improves stock control and reduces picking errors,

Unit Dose System (UDDS) – Prepares individually packaged doses for each patient; enhances traceability and reduces preparation errors,

Automated Dispensing Cabinets (ADCs) – Secure ward-based cabinets; enable on-demand access to medicines with real-time documentation,

Smart Infusion Pumps with Dose Error Reduction System (DERS) – Standardizes infusion parameters in ICUs; prevents dosage mistakes,



Oncology Medication Traceability Platform – Tracks the entire chemotherapy process (prescription → preparation → administration); ensures safety in high-risk therapies,

Methodology

The analysis was built around a standardized model of a **561-bed acute care hospital**, representative of the average facility size across EU countries

Initial investment and **operational savings** were estimated using **country-specific data**

Results were then **scaled to the national level** based on the number of hospital beds and adjusted for **current technology penetration** in each country

A **sensitivity analysis** tested model robustness by simulating variations in hospital size and discount rates

Methodology

The clinical and organizational benefits of automation technologies were identified from the scientific literature, then valued using the Activity-Based Costing (ABC) technique, by estimating the time and resources saved at each phase of the medication cycle,

Technologies	Reduction of wasted medications	Stock reduction	Reduction of medication errors	Reduction of processing time
Inventory robots	−100% (Ahtiainen et al,, 2020)	−26,4% (Giménez et al,, 2019)	−16 % (Franklin et al,, 2007)	−31,4% (technicians) (Ahtiainen et al,, 2020)
Unit Dose System (UDDS)	−100 % (Herrmann et al,, 2024)	0 % (supposed)	−53 % (Berdot et al,, 2016)	−5,8% (nurses) / −10% (technicians) (Herrmann et al,, 2024)
Automated Cabinets (ADC)	−100 % (Cousein et al,, 2014)	−60,6% (Chen et al,, 2022)	−53 % (Berdot et al,, 2016)	−80% (nurses) / −50% (pharmacists) (Mathy et al,, 2020)
Smart pumps with DERS	—	—	−100 % (Kastrup et al,, 2012; Waterson & Bedner, 2019)	−69,8% (nurses) (Kastrup et al,, 2012)
Oncological Traceability System	−100 % (Ferrario et al,, 2020)	−21 % (Terkola et al,, 2017)	−75–89 % (Reece et al,, 2016; Sarfati et al,, 2015; Aita et al,, 2013)	−44% (pharmaceuticals) (Ferrario et al,, 2020)

ROI, NPV and PBT

- ROI (Return on Investment): indicates the profitability of an investment by calculating the relationship between net profit generated and capital invested,

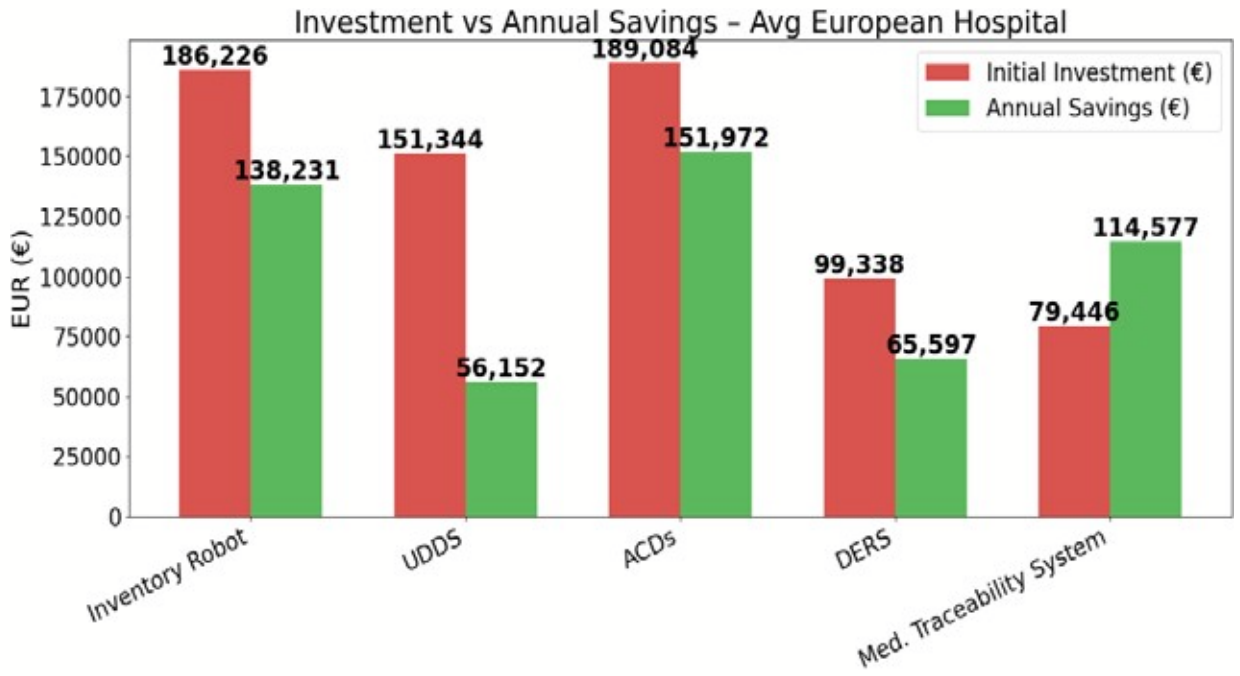
$$\text{ROI} = \frac{(\text{Total Costs} - \text{Total Savings})}{\text{Total costs}}$$

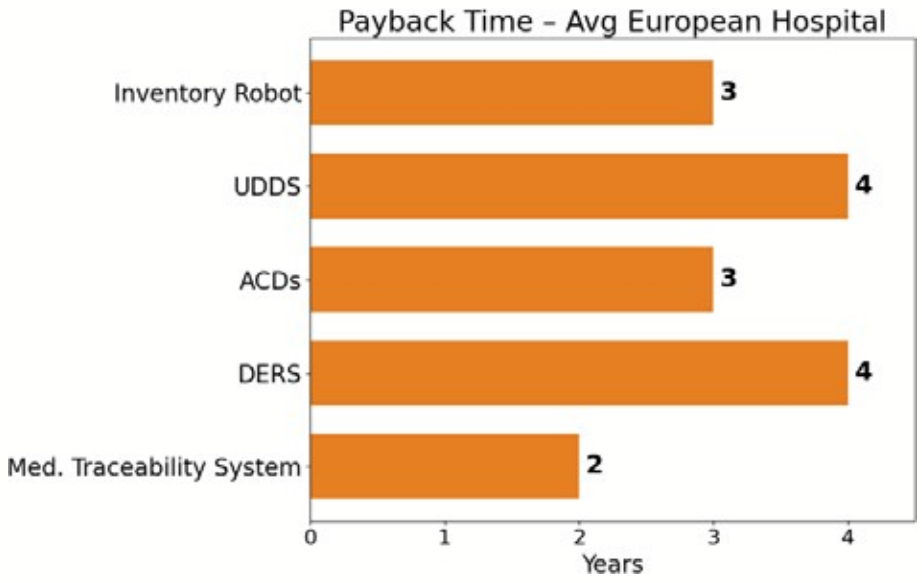
- NPV (Net Present Value): measures the net present value of future cash flows generated by an investment, discounted at the required interest rate, A positive NPV indicates economic viability,

$$\sum_{t=2024}^{2034} \frac{\text{Net Cash Flow}}{(1 + \text{inflation rate})^t}$$

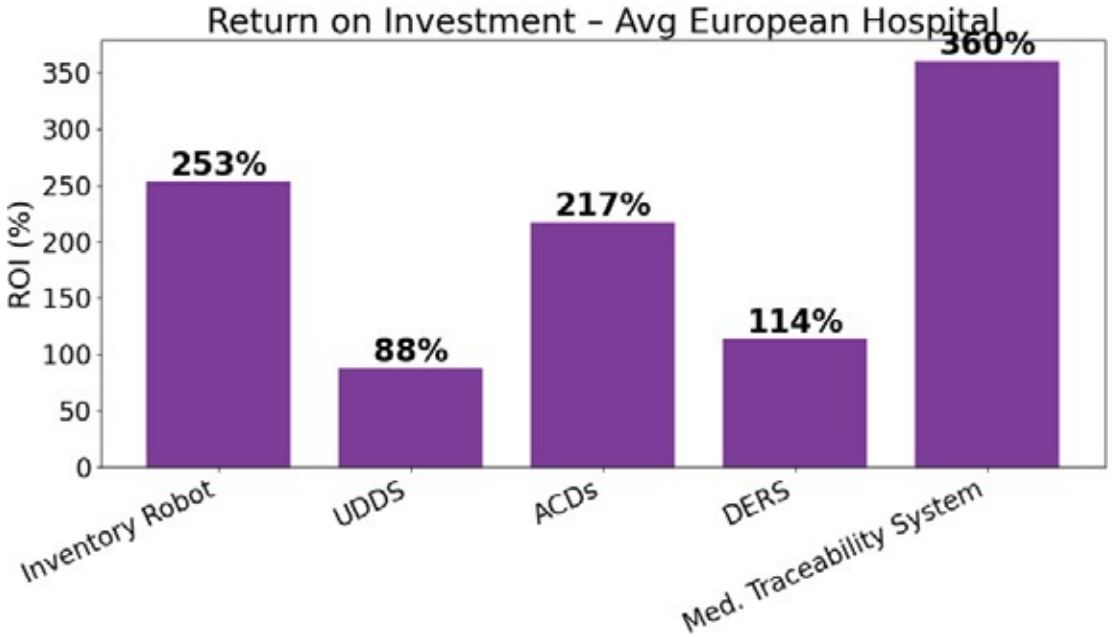
- PBT (Payback Time): represents the time needed to recover the initial investment through generated cash flows, without considering the time value of money,

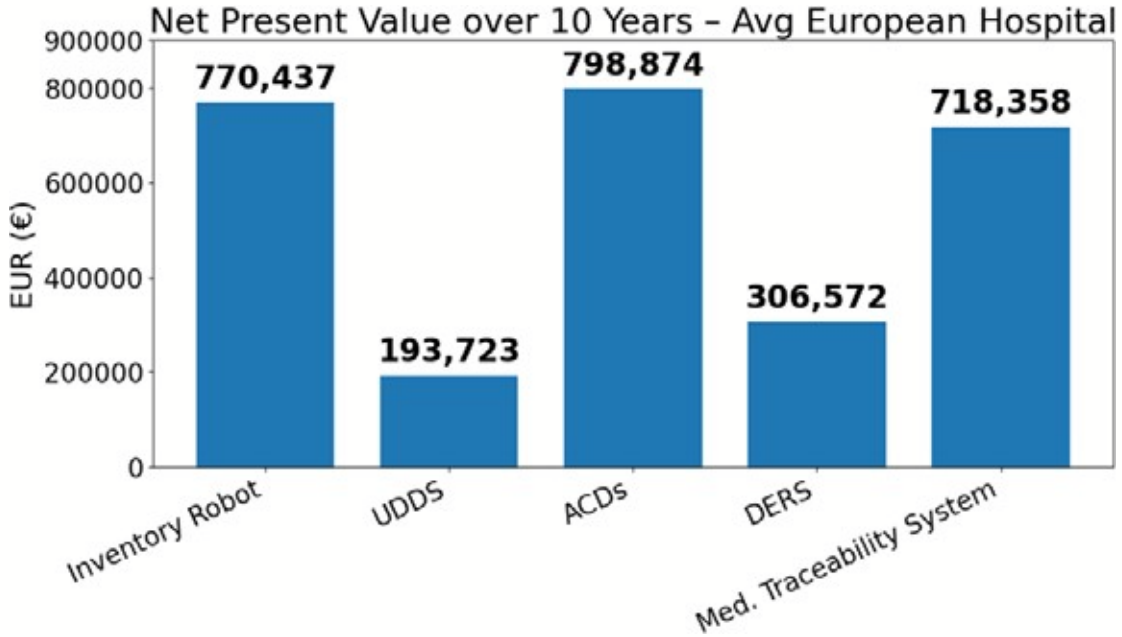
Investment and annual savings – 5 Technologies





Financial indicators – 5 technologies

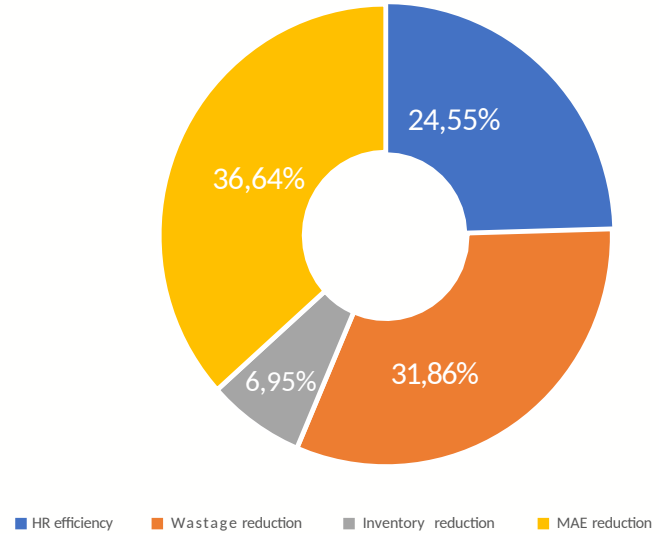




Savings Breakdown

Technology	HR efficiency savings	Wastage reduction savings	Inventory reduction savings	MAE reduction savings	Total Annual savings
Inventory Robot	99,885,092 €	285,117,237 €	58,838,174 €	8,411,016 €	452,251,520 €
UDDS	89,280,038 €	88,988,291 €	0 €	12,624,694 €	190,893,022 €
ACDs	90,510,064 €	167,674,950 €	66,408,609 €	219,013,218 €	543,606,841 €
DERS	18,075,228 €	0 €	0 €	189,710,489 €	207,785,717 €
Oncology	144,405,207 €	31,993,020 €	0 €	230,119,044 €	406,517,271 €
TOTAL	**442,155,629 €**	**573,773,498 €**	**125,246,782 €**	**659,878,461 €**	**1,801,054,370 €**

Distribution of savings among cost drivers



Financial indicators

Level	NPV (€)	ROI	Payback Time (years)
Hospital	2,787,964	202%	3,4
Europe (27 EU + UK)	9,671,881,127 €		

Limitations and robustness

Standardized assumptions: the model uses an “average” 561-bed hospital and assumes homogeneous medication-use processes, Local variations in workflows (e,g,, oncology protocols) may lead to different impacts,

Use of averages: country-level estimates rely on mean values for salaries, drug prices, and adoption rates; this introduces approximation and may not capture local heterogeneity,

Scaling up: extrapolation from hospital to national/EU level adds uncertainty, especially in smaller facilities or lower-GDP countries,

Sensitivity analysis: varying hospital size (±20%) and discount rate (±20%) confirmed the overall robustness: ROI and Payback remained stable

Conclusions

Financial Performance & Economic Viability (The ROI)

- **Predictable Value Creation:** Demonstrated **ROI between 131% and 200%**, with a consistently positive Net Present Value (NPV) across diverse healthcare settings,
- **Rapid Capital Recovery:** Initial investments achieve a full **payback in less than 5 years**, proving financial viability even in resource-constrained environments,
- **Sustainable Resource Allocation:** High-fidelity economic modeling confirms that automation is not a cost, but a high-yield strategic investment

Clinical Excellence & Operational Impact (The Value)

- **Immediate Safety Gains**: Transitioning to Closed-Loop Medicines Management drastically reduces medication errors and lowers the cognitive load on clinical staff.
- **Time Released Back to Care**: By streamlining workflows and optimizing stock, automation eliminates low-value tasks, allowing professionals to focus on patient outcomes.
- **Process Resilience**: Real-time interoperability and intelligent ward stock management reduce waste and ensure supply chain transparency.

Strategic Governance & Scalability (The Leadership)

- **HTA-Driven Decision Support**: The study provides a robust framework based on Health Technology Assessment (HTA) principles to guide clinical and economic sustainability.
- **Strategic Governance & Adoption:** > Success is driven by **rigorous HTA protocols** and **clinical ownership**. Impact is secured through a staged rollout that aligns technological capabilities with organizational maturity.
- **Universal Value Drivers**: Despite systemic differences across Europe, the core drivers—safety, efficiency, and waste reduction—are globally scalable and consistent.

Thank you!

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