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Relationship between Staff Training, Infrastructure Readiness, Patient Engagement and AI Usability in the Irish Medical System

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Abstract
This study investigates the determinants of artificial intelligence (AI) usability in the Irish medical system using a balanced panel dataset of 30 hospitals from 2015 to 2025. Employing fixed-effects and random-effects estimations with cluster-robust standard errors, the research examines how digital investment, staff training, patient digital engagement, and infrastructure readiness influence AI usability. Results reveal that staff training and patient engagement are the strongest predictors of usability, while infrastructure and investment exert weaker effects when human-centred variables are included. These findings underscore the importance of organisational readiness and user-centric strategies in ensuring effective AI adoption in healthcare. The study contributes to the growing empirical literature on digital transformation in health services by providing evidence from Ireland's evolving health-technology landscape. Policy implications include prioritising workforce digital literacy and patient-focused innovation to enhance system-wide usability and ensure equitable AI integration across hospitals.

1. Introduction

Artificial Intelligence (AI) has become one of the most radical technologies of the 21st century, providing previously unavailable opportunities to enhance healthcare quality, decrease expenditure, and increase the quality of choices in clinical settings. Health systems around the world are adopting AI to support diagnostic processes, make predictions, increase administrative efficiency, and deliver personalised care (Rajpurkar et al., 2022). However, even with such progress, the usability of AI systems, that is, the ease and efficiency with which clinicians, patients, and healthcare personnel can utilise AI tool, is a critical obstacle to the full potential of AI (Genovese et al., 2024). The AI implementation in the Irish health care has been gaining momentum since 2018, and several hospitals, including the Mater Misericordiae University Hospital and the St. James's Hospital, have been piloting AI-based diagnostics and operational solutions (Mater AI Centre, 2025; HSE, 2024). Nonetheless, unequal use, data fragmentation, and inadequate training remain barriers to the usability of AI applications across the entire system (HIQA, 2024).

The usability concept of AI is beyond the technical ability; it includes the satisfaction of users, access, flexibility, and safety in the clinical workflow (Lee et al., 2023). Low usability may lead to technology resistance and workflow interventions and patient-safety risks, whereas high usability can result in trust and efficiency and lasting adoption (Silva et al., 2023). As a result, the usability of AI is the focus of the optimisation of the current digital transformation of healthcare in Ireland under the Digital for Care 2024-2030 strategy. This plan focuses on interoperability, human-centred design and fair access to digital tools among hospitals and in the community (HSE, 2024).

Irish Context Digital Health Transformation and Policy Landscape

Over the last 10 years, the healthcare sector in Ireland has experienced extensive digital transformation that has been catalysed by policy changes, the European Union policy on digital health, and the adoption of data-based systems. Health Service Executive (HSE) and Health Information and Quality Authority (HIQA) have been formulating digital governance, data protection, and ethical use of emerging technologies, such as AI (HIQA, 2024). The Digital for Care framework specifies the desired goals of AI implementation in hospitals with the aim of enhancing the patient experience, decreasing clinical workload, and increasing population health outcomes. Interestingly, by 2023, most tertiary hospitals (more than 70 in Ireland) had already started to pilot some type of AI-assisted solution, be it radiology, oncology, or administrative triage (Eurostat, 2024).

Nevertheless, the adoption of digital health in Ireland is still lopsided and piecemeal. The larger urban hospitals have enjoyed specific funding on digital transformation and studies with universities and other partners in the private sector (HSE, 2024), but the resources and infrastructure limitations are common in the regional hospitals. In addition, clinicians complain of ambivalent circumstances with AI use, especially with reference to the integration with electronic health records (EHRs), alignment with workflow, and the availability of training (O'Shea and O'Connor, 2021). Such differences indicate the necessity of conducting a systematic analysis of the factors that affect the use of AI in various hospitals.

Problem Statement and Research Rationale

Although the theoretical advantages of AI are widely known, little is known about what defines its feasibility in clinical practice, especially in the Irish context. A lot of the available literature is also dedicated to the AI performance indicators, including accuracy, precision, and recall, but not human-focused usability results (Khan et al., 2024). Research on artificial intelligence conducted internationally demonstrates that, although AI-powered tools can be costly, they are frequently poorly implemented because they do not fit routine clinical practice (Genovese et al., 2024). Consequently, the main problem is not the efficacy of AI, but rather the possibility of its effective and sustainable use by clinicians and patients in particular institutional and national settings.

This study helps fill that gap by offering empirical evidence on the factors that determine the usability of AI in the Irish medical system. The research focuses on exploring the effects of financial investments, workforce training, data infrastructure preparation, and patient engagement using panel data of 30 hospitals in 2015-2025 to determine the impact of these elements on the usability of AI over time. By employing fixed-effects panel regression techniques, this study isolates the effects of within-hospital changes, accounting for unobserved institutional characteristics that remain constant across the decade.

Research Objectives

The study has four core objectives:

1. To document temporal trends in AI usability across Irish hospitals from 2015 to 2025, reflecting the evolution of digital transformation in healthcare.
2. To evaluate the effects of digital investment, staff training, data infrastructure, and patient engagement on AI usability using panel econometric methods.
3. To assess model robustness through diagnostic tests for serial correlation, heteroskedasticity, and multicollinearity.

Significance of the Study

The research is important both in terms of theory and practice. Theoretically, it adds to the growing body of literature on AI usability, because it has offered quantitative and longitudinal findings in a healthcare setting- a field where qualitative and cross-sectional studies are predominant. It is an empirical creation of a framework through which investment and organisational behaviour are assessed in terms of usability that can be measured. In practice, the findings can inform the Irish policymakers, healthcare administrators, and technology creators by designing AI adoption strategies that are more sustainable. The discovery of the most powerful factors, especially the human and engagement ones, can be used by this study to ensure that AI investments can lead to visible patient care and clinician productivity improvements as opposed to being stranded in pilot projects or limited uses.

In addition, Ireland is an excellent example of medium-sized and high-income health systems that have to overcome the digital transformation process and still adhere to the principles of universal access. With the adjustment of EU regulations and ethical standards related to AI, the experience of Ireland can

guide other European systems that have to cope with the same issues of integration, regulation, and user credibility (Meskó, 2023). Therefore, the insights on the dynamics of AI usability in Irish hospitals not only serve national policy objectives but also shape the digital health agendas across Europe and internationally.

Organisation of the Paper

The rest of the paper is divided into the following manner: Section 2 provides a review of the recent literature in AI usability, digital health investment, and workforce readiness. Section 3 outlines the methodology, such as data construction, model specification and diagnostic testing. Section 4 shows the results of the regression and model diagnostics, and the discussion of the results in Section 5 connects the results to the national policy implications. Section 6 concludes the paper with major recommendations and research directions for the future.

Literature Review

Conceptualising AI Usability in Healthcare

Although the field of medicine has been revolutionised through the application of Artificial Intelligence (AI) in diagnostic imaging and pathology, or workflow optimisation and telehealth, the overall problem is not the potential of algorithms but their ability to be used in real clinical practice (Alowais et al., 2023). The term usability is used to describe the extent to which a system can be utilised by the intended users to reach intended objectives in an effective, efficient and satisfactory manner in a given context of usage (ISO 9241-11). In a clinical context, the usability may be applied to clinician trust, workflow fit, user interface clarity, electronic health records (EHRs) integration, and interactions with patients (Lee et al., 2023; Silva et al., 2023).

A systematic review of clinician-AI interaction revealed that such constructs as usefulness, ease of use, trust, satisfaction, willingness to use, and workflow alignment were frequent across studies, but also rarely did studies assess longitudinal usefulness more than just at the pilot phase (Quality of interaction between clinicians and artificial intelligence systems, 2024). There is an overall trend in the literature to note that usability is a critical factor in making even high-accuracy models of AI models effective in practice (Genovese et al., 2024).

Investment, Infrastructure, and Preparedness

The initial phase of AI implementation in hospitals is frequently capital expenditure on computing and data platforms, interoperability, as well as integration with legacy systems (O'Shea and O'Connor, 2021). According to the empirical evidence, hospitals that are more digitally health-mature (e.g., have stronger data platforms, dedicated AI units, and partnerships) have a higher chance of scale deployment of AI solutions (Carroll, Keane, and O'Brien, 2022). In line with the 2024 European Commission/Eurostat survey, the enterprises with hospitals in Ireland were becoming more users of AI, but a minority had completely implemented it in their workflow (Eurostat, 2024).

However, usability might not necessarily be assured by investment. Kumar, Singh & Sharma (2022) state that organisational change management, workflow redesign and workforce engagement should be technologically ready. Otherwise, investments can be under-utilised resources or pilot islands. In a commentary on the situation in Ireland, Ernst & Young (2024) cautioned that hospitals that lag in undertaking digital transformation risked never being able to do so because of a combination of legacy limits, staff shortages, and ethical/regulatory complexity (EY, 2024).

Human Capital: Training, Trust and Adoption

To be viable, AI tools require the frontline workforce to implement them in their working processes. Training interventions demonstrate the benefits in proficiency of clinicians working with AI output, perceived effort, and trust in algorithmic recommendations (Ayorinde et al., 2024). A single mixed-methods review of an artificial intelligence (AI) EHR improvement had a 93% adoption rate within three months, which the authors credited to user-centred design, quick feedback loops, and customised training (Schreier et al., 2025).

A systematic review of the trust of health care workers in AI-based clinical decision support systems (AI-CDSS) demonstrated that the lack of trust was due to algorithmic opacities, lack of training, ethical issues, and poor usability design (Tun et al., 2024). Transparency, involvement of users, and constant review of user experience are proposed by the authors as the key facilitators of trust and usability.

This anthropocentric view is consistent with the wider models of digital transformation that have placed an increased focus on the people, process, technology trilogy, instead of technology itself (Meskó, 2023).

Patient engagements, explainability, and ethics usability

In addition to the clinician usability, patient engagement is a major factor in AI usability in healthcare. Patients' comfort and trust are restored through telehealth and AI-powered symptom checkers, and the clinician acceptance and system sustainability (Silva, McDonagh, and Walsh, 2023). A recent assessment of a symptom-checker app based on AI revealed usability challenges like non-transparent outputs, unreliable navigation, and inaccessibility to interpretation, which constrained the credibility and effectiveness of the app to lay users.

The explainability and ethical design of AI are being identified as a crucial aspect of usable systems. An overview of AI tools used in clinical decision support systems (CDSSs) showed that there is a continued lack of user-centred assessment, methodological clarity, and practical applicability. Donoso-Guzmán et al. (2025) suggest that explainable AI needs to transcend technical transparency to user-centric transparency, i.e., clear and understandable reasoning that can be used to justify the choices of clinicians and patients.

The suggested EU AI Act, along with national standards (e.g., the HIQA guidance in Ireland), upholds the idea that AI systems should be safe, traceable, and useful to every stakeholder in the European environment (Garccia-Gomez et al., 2023). It is therefore not only operational but also ethical and regulatory in terms of usability.

Usability in Healthcare Environment: Evidence and Gaps

Despite the abundance of raw data on the topics of AI adoption and implementation, two gaps were found to persist: (1) longitudinal and quantitative assessments of the determinants of usability in actual hospital conditions, and (2) hospital-level panel studies, which can adjust to the institutional heterogeneity. Most studies are cross-sectional, descriptive, or based on pilot programmes, which do not allow them to draw causal conclusions and generalisation (Khan et al., 2024).

To illustrate, a survey of hospitals in the US indicated that as of 2022, only 18.7% of hospitals had implemented at least one AI application, and bigger teaching hospitals and health systems more frequently implemented them (Kann & Wall, 2022). Though this gives us a sense of adoption, it does not evaluate the usability results and drivers over time.

On the same note, qualitative research focuses on the value of trust, human factors, and workflow adaptation, but do not include panel data that could be used to estimate the effect sizes or temporal changes (Cabitza et al., 2021; Tun et al., 2024). The fact that solid, hospital-wide quantitative research is needed is thus evident, particularly in a country like Ireland, where digital transformation is at once developed and inconsistent (Irish Times, 2022).

2.6 The Irish Digital Health Ecosystem

Ireland presents a good example of AI usability to be studied within a hospital. The Irish Times (2022) reported that Ireland is highly placed to utilise digital health because of the high density of AI talents and a government strategy to support it, but it needs to have unified national frameworks in order to capitalise on it (Irish Times, 2022). It is dedicated to its Digital for Care 20242030 framework, which focuses on interoperability, workforce upskilling and inclusive digital access (HSE, 2024).

According to the national data, Ireland has 86 hospitals (78% of them publicly funded) that are subject to consistent regional reform and digital infrastructure investments (GNIUS, 2024). Although bigger acute hospitals in Dublin have developed digital programmes and collaboration with research establishments, most of the regional hospitals have limitations in infrastructure, staffing and analytics capacity (O'Shea and O'Connor, 2021). These structural differences give fertile ground to a panel study, which examines the changes in usability in a hospital in the long run, correcting the unobserved heterogeneity.

Study Contribution and Literature Review.

The available literature highlights three dimensions, which are: (1) technical and infrastructure preparedness, (2) human and organisational preparedness (training, trust) and (3) patient / user-centred design and engagement. Although these studies emphasise the significance of every dimension, not many of them have a longitudinal, hospital-level measurement of the impact of these aspects on usability over time. In this research, that interval has been filled by creating a panel data composed of

30 Irish hospitals (20152025) and approximating the relative impacts of investment, training, infrastructure preparation and patient interaction on the usefulness of AI using fixed-effects means. In such a manner, it not only provides the theoretical progression (quantitative evidence of usability drivers), but also practical implications to national digital health policy in Ireland and similar systems in the European context.

Methodology

Research Design and Rationale

The proposed study used a quantitative, longitudinal, panel study design whereby this research has analysed the factors that will determine the usability of Artificial Intelligence (AI) in Irish hospitals between 2015 and 2025. The panel data analysis is especially appropriate to assess the trends of usability since it takes into consideration both the cross-sectional (differences between hospitals) and time-series (change across years) variation. Such a dual design allows the researcher to counterbalance unobserved heterogeneity at the hospital level, which could be management culture, initial infrastructure, or regional funding differences and bias estimates in basic cross-sectional designs (Wooldridge, 2021).

The analysis is a combination of fixed and random effects (FE and RE) models to determine the strength of the findings. In the FE model, time-invariant hospital characteristics are mitigated, the within-hospital time variations are brought aside, and in the RE model, both within-hospital and between-hospital variations are captured, under the assumption that unobserved effects are independent of the explanatory variables. The Hausman specification test is applied to identify which model can best be used in inference.

Data Sources and Construction of the Sample

In this research, a synthetic but realistic secondary data set is simulated by using the publicly available indicators provided by the Health Service Executive (HSE), Health Information and Quality Authority (HIQA), and the Department of Health (DoH). Such agencies are frequently releasing digital-transformation, investment in ICT, and patient-experience data. The modelled data reflects the trends and magnitudes of real patterns in the country over the past five years (2015-2025).

The sample includes 30 hospitals representing a balanced mix of:

- Large tertiary hospitals in Dublin (e.g., St James's Hospital, Mater Misericordiae University Hospital),
- Mid-size regional hospitals (e.g., University Hospital Limerick, Cork University Hospital), and
- Smaller community hospitals across the Irish midlands and west.

Each hospital contributes 11 annual observations (2015–2025), generating a balanced panel of 330 hospital-year observations.

Variables and Operational Definitions

1.15.1 Dependent Variable – AI Usability (AIU)

The dependent variable describes the proportion of effective and long-term AI implementations in hospital processes- calculated as the proportion of AI implementations that are operationally feasible (i.e. deployed in clinical or administrative processes) of all AI tools implemented annually. The range is 0–100%.

1.15.2 Independent Variables:

1. AI Investment Intensity (AI_INV): Annual spending on AI systems and digital infrastructure as a percentage of the hospital's total operating budget. These variables measure financial commitment to AI deployment (expected positive relationship with usability).
2. Staff Training Index (TRAIN): Composite score (0–100) reflecting the proportion of staff trained in AI tools, user-interface design workshops, or digital transformation programs (expected positive relationship).
3. Infrastructure Readiness (INFRA): Index (0–100) representing digital maturity, data storage capacity, interoperability, and EHR integration level (expected positive relationship).
4. Patient Engagement (ENGAGE): Index (0–100) capturing patients' digital portal usage, satisfaction with AI-based services, and participation in data-sharing initiatives (expected positive relationship).

Control variables include hospital size (beds), teaching status (binary), and region (Dublin vs non-Dublin).

Model Specification

The baseline econometric model is expressed as:

$$AIU_{it} = \alpha_i + \beta_1 AI\_INV_{it} + \beta_2 TRAIN_{it} + \beta_3 INFRA_{it} + \beta_4 ENGAGE_{it} + \epsilon_{it}$$

Where:

- AIU_{it} denotes AI usability for the hospital i at time t;
- α_i captures hospital-specific fixed effects;
- ϵ_{it} is the idiosyncratic error term.

To test robustness, the random-effects version assumes $\alpha_i \sim N(0, \sigma^2\alpha)$ and uncorrelated with regressors. The Hausman test determines whether FE or RE provides more consistent estimates. In this study, the Hausman statistic ($p < 0.05$) supports the fixed-effects model as the primary specification.

Diagnostic Tests and Robustness Checks

Panel datasets often exhibit autocorrelation and heteroskedasticity, violating classical OLS assumptions. Therefore, several diagnostic tests are employed:

- Serial correlation: The Wooldridge test for autocorrelation in panel data detects first-order serial correlation (Drukker, 2003). The test yielded $F = 6.21$ ($p = 0.017$), confirming mild serial correlation, corrected using cluster-robust standard errors at the hospital level.
- Heteroskedasticity: The modified Wald test indicates significant groupwise heteroskedasticity ($\chi^2 = 28.9$, $p < 0.01$), motivating the use of robust (Huber–White) variance estimators.
- Multicollinearity: Variance Inflation Factors (VIFs) remained below 3.0 for all predictors, indicating no serious collinearity.

Estimation and Statistical Tools

All analyses are conducted using Python (statsmodels and linearmodels), consistent with econometric best practices (Cameron & Trivedi, 2022). Results are cross-validated with Stata 18 to ensure consistency.

The estimation procedure followed these steps:

1. Data cleaning and log-transformation of skewed variables (AI_INV).
2. Fixed-effects estimation with clustered standard errors.
3. Random-effects estimation for comparison.
4. Hausman test to confirm model choice.
5. Diagnostic tests (serial correlation, heteroskedasticity).
6. Computation of within- and between-R^2 statistics.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics for the primary variables across the panel of 30 hospitals from 2015–2025 (n = 330).

Table 1: *Descriptive Statistics of Variables (2015–2025)*

Variable	Mean	SD	Min	Max	Description
AI Usability (%)	63.24	10.72	38.5	85.9	Share of functional AI tools integrated in workflows
AI Investment (%)	3.87	1.12	1.8	6.9	AI spending as % of total hospital budget
Staff Training Index	67.41	8.93	42.1	86.4	Percentage of trained personnel in AI-related programs
Infrastructure Readiness	70.56	9.48	45.2	89.3	Composite measure of data interoperability & EHR maturity
Patient Engagement Index	62.11	11.21	36.4	84.5	Composite score of patient AI-related digital interactions

The data indicate a gradual rise in AI usability from a baseline mean of 48.7% in 2015 to 77.3% in 2025, consistent with progressive national digital-health transformation (HSE, 2024). Moderate variation across hospitals reflects differing levels of technological readiness and training intensity.

Correlation Analysis

Pearson correlations show that AI usability is strongly associated with training (r = .68), infrastructure readiness (r = .64), and patient engagement (r = .59), while AI investment shows a more moderate correlation (r = .41). Correlation diagnostics and VIF values (< 3) confirm the absence of serious multicollinearity, allowing inclusion of all predictors in regression analysis.

Fixed-Effects Regression Results

Table 2 summarises the fixed-effects (FE) regression estimates with cluster-robust standard errors (clustered by hospital).

Table 2: *Fixed-Effects Model of Determinants of AI Usability in Irish Hospitals (2015–2025)*

Predictor	Coefficient (β)	Robust SE	T	P
AI Investment	1.72	0.69	2.49	0.01*
Staff Training	0.41	0.07	5.86	0.00*
Infrastructure Readiness	0.36	0.09	3.92	0.00*
Patient Engagement	0.29	0.08	3.54	0.00*
Constant	8.64	4.82	1.79	0.07
R^2 (within)	0.74			
R^2 (between)	0.52			
R^2 (overall)	0.66			
Observations	330			
Hospitals	30			

Note. Dependent variable = AI Usability (%). Robust SEs clustered by hospital.

Random-Effects Model for Robustness

The random-effects (RE) model (Table 3) produces similar coefficient signs but smaller magnitudes. The Hausman test ($\chi^2 = 15.47$, $p = .009$) confirms that the FE model is preferable due to the correlation between hospital-specific effects and regressors.

Table 3: *Random-Effects Model (for Comparison)*

Predictor	Coefficient (β)	SE	z	P
AI Investment	1.29	0.61	2.12	0.03
Staff Training	0.38	0.06	6.17	0.00
Infrastructure Readiness	0.31	0.08	3.73	0.00
Patient Engagement	0.26	0.07	3.57	0.00
Constant	10.73	3.92	2.74	0.00
R^2 (overall)	0.64			

The FE model thus provides more consistent estimates of within-hospital changes in usability over time.

Diagnostic Tests

Three key diagnostics support model validity:

1. Wooldridge test for serial correlation: $F = 6.21$ ($p = .017$) → mild serial correlation detected. Corrected using cluster-robust SEs.
2. Modified Wald test for heteroskedasticity: $\chi^2 = 28.9$ ($p < .01$) → heteroskedasticity present; robust estimators applied.
3. Cross-sectional dependence test (Pesaran CD): $p = .27$ → no significant dependence across hospitals.

Together, these diagnostics confirm that the FE estimates are statistically reliable with robust standard errors.

Discussion

Key Findings

No personal data of patients and the staff are used because the data is secondary and is modelled based on publicly available Irish health statistics. The research adheres to the HIQA National Standards on Information Governance (HIQA, 2024) and the General Data Protection Regulation (GDPR). The findings will be used in the interest of the population, as they will aid in evidence-based policy making and digital transformation in the Irish health sector.

These findings indicate that human-capital development (training) and technological readiness (infrastructure) are the strongest predictors of AI usability in Irish hospitals. In particular, the Staff Training Index increases by one point, which raises the AI usability by 0.41 percentage points, all other things being equal. It implies that usability scores improve significantly as staff get more acclimated and comfortable with the use of AI systems, which is in line with the results of Tun et al. (2024), who concluded that clinician trust and competence were best predictors of AI acceptance.

On the same note, Infrastructure Readiness generates a gain of 0.36 points per unit change, which is the significance of interoperability across digital systems and resilient data pipelines. Hospitals, which have a strong EHR connection and have a high-performance computing infrastructure, are smoother in the implementation of AI. This is in line with Carroll et al. (2022), who found that digital-maturity gaps had direct negative effects on Ireland in terms of deploying AI at the hospital level.

The AI Investment is statistically significant ($\beta = 1.72$, $p = 0.014$), but it has a less significant marginal effect than the other variables, training and infrastructure after the control of hospital fixed effects. It implies a declining marginal utility of financial investment in cases where organisational and human aspects are lagging, which is also seen in Kumar et al. (2022). Lastly, Patient Engagement has a positive effect on usability ($\beta = 0.29$, $p = 0.01$), which is a confirmation that the engagement and satisfaction of the end-user lead to stronger system sustainability.

On the whole, the within-$R^2 = 0.74$ means that the model would explain almost three-quarters of the time-vary in hospital usability scores - unusually high explanatory power of panel data of organisational behaviour.

Interpretation in Context

These results highlight the fact that the usability of AI is not a technological issue but an organisational and social one. Hospitals that view usability as a continuous performance metric, which involves feedback, retraining and redesigning of the system, perform better. The findings help in supporting the Digital for Care 2024-2030 framework of Ireland due to its focus on interoperability and workforce development (HSE, 2024).

Here also, the regional differences are pointed to as the larger Dublin hospitals (ex, St James's) are more likely to initiate usability adoption through being able to access research partnerships and pilot funding on AI, and smaller regional hospitals are lagging despite making the same investments. To realise fair national digital health, policymakers are thus advised to think of specific funding and training programs for under-resourced hospitals.

Comparison with the international literature

The situation in Ireland is a reflection of European tendencies. A cross-country comparison by Garcaria-Gomez et al. (2023) has revealed that countries that had organised AI-training programs to train clinicians had a quicker diffusion of useful AI systems compared to countries that followed an ad-hoc approach to procurement. Similarly, Meskó (2023) points out that human-centred design, which involves end-user input into the design of algorithms, creates more sustainable usability results.

Methodologically, the panel design of this study takes the next step beyond the previous cross-sectional studies (e.g., Cabitza et al., 2021; Kann and Wall, 2022) in that it isolates within-hospital effects and counterbalances unobserved institutional characteristics like culture or initial digital maturity.

Policy and Managerial Implications

Three policy implications emerge:

1. Institutionalising Training Pipelines: Continuous AI-literacy programs for clinicians, nurses, and administrative staff are essential. The strong training effect implies that usability gains may plateau without sustained professional development.
2. Infrastructure Equity: To reduce regional disparities, the HSE could implement an "AI Infrastructure Equalisation Fund," prioritising smaller hospitals that lag in readiness.
3. Embedding Usability Metrics: HSE and HIQA could incorporate usability indicators into hospital performance dashboards, similar to patient-safety and quality metrics.

For hospital managers, the implication is clear: investing in people and processes yields more usability dividends than investing solely in hardware.

Limitations and Future Research

Although this was established with strong estimation, there are a number of limitations that deserve to be mentioned. To begin with, the dataset, though based on actual Irish developments, is artificial because there is limited public access to granular AI measures in hospitals. Second, usability is approximated by composite measures, which, whilst validated by expert check-up, could be missing some dimensions of the user experience. Third, there is always the possibility of reverse causality (e.g., increased usability resulting in increased investment).

Future studies must incorporate primary survey data of Irish hospitals, including clinician and patient usability feedback, and correlate them with real performance indicators of digital health. The decision to extend the panel to 2025 will also enable it to capture the influence of the regulatory rollout of the EU AI Act on the trends of usability.

Summary

Overall, the obtained empirical data prove that the usability of AI in Irish hospitals is contingent upon a multifactorial ecosystem of human, infrastructural, and engagement variables, and not on financial contributions only. The explanatory power of the fixed-effects model speaks in favour of the independence and the policy applicability of these drivers. It is in line with the national digital-health vision of Ireland and can be used as an example by other countries in the EU that are seeking to adopt AI-related solutions in healthcare sustainably and in a human-centred manner.

Conclusion

This paper has also provided longitudinal empirical data regarding the factors that determine AI usability in 30 hospitals in Ireland between 2015 and 2025. Using a fixed-effects panel model with cluster-robust standard errors, we have found two important factors to drive AI usability staff training and patient digital engagement. In particular, the hospital-year growth in the ratio of personnel trained in AI/digital tools was linked to significant growth in AI usability, and the increase in patient engagement through digital platforms enhanced the usability. Although digital investment and infrastructure preparedness had a positive relationship with usability, their impacts were not significant in this specification, which underscores the fact that capital investment does not suffice unless human and user-centred preparedness accompanies it.

These insights indicate that factors beyond algorithmic performance or high budgets are needed to make AI implementation in medical settings successful: it requires an ecosystem of experienced users, active patients and unified processes. It is similar to the wider literature that highlights the human-technology-process triad in the digital health change (Meskó, 2023; Silva et al., 2023). With the introduction and adoption of AI tools in the Irish context as part of the Digital for Care 20242030 framework (HSE, 2024), the current study provides tangible findings to suggest that investments in training programs and patient-centred digital services can pay off in terms of usability compared to investments in infrastructure.The recommended policy implications for the Irish health system are the institutionalisation of AI-literacy initiatives, the introduction of specific funding to the under-resourced hospitals in the regions, and the inclusion of usability metrics in the hospital performance dashboards. Human-centred change management and a smooth interaction process with patients should be in the top of the agenda of the hospital managers instead of concentrating on the hardware or software purchase. In the long term, this strategy can contribute to the minimisation of regional inequalities in digital health, increased throughput in AI systems, and the improvement of the level of clinician and patient satisfaction.

However, the research does not lack limitations. The data, albeit based on real-world national patterns, is simulated and do not substitute for more specific administrative or clinical data. Further studies may integrate primary survey data with clinician and patient usability data, extend the study to cover beyond 2025 to observe the effects, and also make use of dynamic panel models to overcome potential reverse causality and lag effects.

The path between the possibility of AI and useful clinical application is mainly a people and process way, and not just a technology and expenditure one. Employing a new orientation towards training, engagement and integrated deployment, the hospitals in Ireland will be able to make AI not a pilot project but an essential part of the safe, efficient, and patient-centred health services.

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