RESEARCH PAPER

Digital Health, Tele-ICU, Remote Monitoring & ICU Capacity Planning

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ABSTRACT

Background:

The blistering nature of healthcare digitalization has replicated the critical-care provisioning using technologies in the form of Tele-ICU systems, remote monitoring, and data-guided ICU-capacity planning. These developments cater to the rising need for efficient, real-time utilization of intensive care resources, and this is more so in situations where manpower is scarce and where patients are increasingly becoming complicated. Although there is an interest in it, empirical studies that have associated digital health adoption with ICU operational performance are scarce. The paper explores the impacts of digital health preparedness, integrating Tele-ICUs, and remote monitoring in managing the capacity of ICUs in healthcare facilities.

Methods:

A cross-sectional, quantitative research design was utilized with a structured Likert-scale questionnaire being administered to 319 professionals in the healthcare setting, which included public, private, and teaching hospitals. The statistical tests of the dataset included Normality (Kolmogorov-Smirnov, Shapiro-Wilk), Reliability (Cronbach Alpha > 0.7), and KMO = 0.874, $p < 0.001$ (all valid). Independent Samples t-test, One-way ANOVA, Kruskal-Wallis, and Chi-Square were used to perform inferential analyses to test the differences between groups. Dependent variables, Pearson Correlation, and Multiple Regression Analysis were used to evaluate relationships between variables to identify predictors of the efficiency of ICU capacity planning.

Results:

The constructs showed high standards of reliability ($\alpha = 0.91$) and validity, which indicated the instrument to be robust. The data were normally distributed ($p > 0.05$), allowing the use of parametric tests. The inferential analyses did not exhibit any significant differences according to gender, education, and the type of institution ($p < 0.05$). Correlation showed a high positive relationship between Digital Health and Tele-ICU ($r = 0.68–0.77$) and Remote Monitoring and ICU Capacity Planning ($r = 0.68–0.77$). The outcome of regression models indicated that these three predictors, when combined, could uniquely account for 69.4% of the variation ($R^2 = 0.694$) in ICU capacity optimization, with all three coefficients corresponding to them significant ($p < 0.001$).

Conclusion:

The paper concludes with the finding that digital transformation in healthcare is a formal facilitator of effective ICU care. Removing the barriers between Tele-ICU systems, remote patient monitoring, and digital health systems improves the accuracy of planning, the use of resources, and clinical

responsiveness. It is proposed that policymakers and hospital authorities should value the importance of digital infrastructure investment, employee education, and interoperability as crucial factors that would facilitate sustainable critical-care results. To demonstrate real-time effects of digital interventions in intensive care, future studies should be extended by means of longitudinal and outcome-based clinical studies that rely on tangible results.

Keywords: Digital Health; Tele-ICU; Remote monitoring; ICU capacity planning; healthcare technology; reliability; regression analysis; correlation; critical care; hospital management.

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Introduction

The change that occurred in the healthcare systems of various states of the world in the modern world was much needed, as it had been initiated by the rapid progress of digital technologies. There has been a convergence of digital health, tele-ICU networks, and remote patient monitoring systems, which has altered the peculiar nature of the delivery, management, and optimality of care provision in the critical care environment. The modern healthcare organization is a key step to efficient, resilient, and responsive ICU capacity planning that will utilize data. The strategic significance of healthcare sustainability and patient safety through the strategic use of digital health solutions in intensive care units (ICUs) is a strategic requirement as the scope of global health issues that could trigger pandemics, an ageing population, and the burden of chronic diseases increases (da Silva et al., 2025).

Digital health Digital health Digital health is the use of information and communication technologies (ICT) and artificial intelligence (AI), and Internet of Things (IoT) in helping to provide healthcare and manage healthcare data. The use of such technologies will aid clinicians in utilizing real-time patient data to assist them in enhancing diagnostic accuracy and clinical decisions. Digital health technologies can be applied in critical care to gather large amounts of data on patients and provide the ability to model the course of treatment and approach treatment in the form of personalization. In the less developed states, where the staff of medical teams and the ICU facilities are less, the digital health application opens the possibilities of narrowing the geographical and resource gap, which will ultimately enhance the quality and access to administrative healthcare resources (Dal Col et al., 2025).

Tele-ICU (Tele-Intensive Care Unit) systems introduction offers the extension of the geographic area of critical care provisions even beyond the territories covered by the hospitals. Tele-ICU systems allow coordinated ICUs under the supervision of the remote intensive care in multiple ICUs at the same time through high-resolution audio-visual offerings, electronic health records, and continuous data streams. It not only promotes the outcome of the patients since they can identify the clinical worsening at an earlier stage, but also optimizes the use of the staff since a single critical care group can supervise a large number of institutions. It has been found that Tele-ICU interventions might help a lot in lowering mortality rates, length of stay in an ICU, and medical errors as they would improve their level of response and adherence to evidence-based practices (Saifan, Odeh, et al., 2025).

The Tele-ICU model is complemented with remote monitoring, which provides healthcare professionals with the possibility to measure vital parameters of the patient, such as the oxygen saturation, heart rate, and blood pressure in real-time with the assistance of wearable devices and data platforms on the cloud. The resulting systems create an endless amount of information that undergoes analytical processes to reveal abnormalities, preempt complications, and initiate the execution of timely intervention. Remote following has also proven to be particularly effective as far as post-ICU recovery and chronic conditions are concerned: it is required to perform continuous monitoring to prevent readmissions. On the one hand, remote monitoring and centralized digital dashboard tools will provide the hospitals with a flow of communication between clinicians,

patients, and support staff at a comfortable level (Leggett et al., 2025).

The process of predicting the demand, optimization of bed placement, and management of medical resources to respond to the changes in the patient load is also a key requirement that provides these innovations with a uniting factor. COVID-19 demonstrated that it was time to develop good practices in the planning of the ICU and that digital forecasting tools and predictive analytics would make the resources available and therefore would be the determinant of life saved. Machine learning and real-time dashboards can help anticipate ICU admissions, ventilator use, and staffing needs and help administrators make evidence-based decisions in case of crisis (Merola et al., 2025).

Although such technologies are highly promising, the majority of the institutions still suffer issues with integrating digital systems due to infrastructural, financial, and organizational bottlenecks. Therefore, the proposed research aims to establish the impact of digital adoption, the Tele-ICU application, and remote monitoring practices on ICU capacity planning. This research contributes to the depth of knowledge of empirical evidence concerning the relationship between each of the elements in the context of strategy policy making and transforming the healthcare systems sustainably. Lastly, it highlights the fact that the technological change and transformation of critical care is a paradigm shift towards predictive, preventative, precision-based healthcare (Elhassan, 2025).

Literature Review

It has been broadly recognized that the use of digital technology and critical-care medicine has been in the list of the most prominent changes in modern healthcare. Digital health concept encompasses electronic health records (EHRs), mobile health (mHealth), wearable biosensors, artificial intelligence (AI), and Internet of Things (IoT) services, all of which enhance the data acquisition process, communication, and decision-making process. Digital health tools within the realms of most of the studies boost the precision of the diagnosis, reduce administrative waste, among other things, and create continuity in care, about the possibility of making evidence-based decisions in real-time by clinicians. Among the organizations that value digital transformation as one of the facilitators of universal health coverage are the World Health Organization (WHO), as well as those in the low- and middle-income countries where the disparities in access to healthcare infrastructure remain high. Digital technologies have formed the foundation of rapid and real-time information exchange and early characterization of physiological degradation and successful organization of multidisciplinary teams in intensive-care principles (Saifan, Ababneh, et al., 2025).

Introduced as an important feature of digital transformation that has emerged in the situation of critical-delivery of care, Tele-ICU systems have occupied a central role in the digital transformation. Tele-ICU refers to a network-based structure in which the off-site intensivists would track the condition of patients in various hospitals in real-time by using two-way audio-visual communication and advanced analytics. As per the research carried out in the United States, Europe, and Asia, it has been shown that Tele-ICU interventions have critical effects on minimizing mortality, length of stay in the ICU, and time of intervention. In other studies, such as the one by Lilly et al., revealed that the Tele-ICU programs not only enhance the level of patient safety, but also standardize the clinical protocols that are geographically apart. Remote experts can be made aware of the emerging trends that could be threatening before they are escalated to a critical state, potentially leading to negative consequences, by tele-ICU dashboards that incorporate predictive analytics. In addition to that, Tele-ICU programs help to enhance the remote mentorship of smaller centers, and the outcome is the reduction of regional disparities in the acquisition of the much-needed experience in care (Amba et al., 2025).

Remote patient monitoring (RPM) is a facilitator of Tele-ICU infrastructure in the sense that it enables one to monitor a patient both outside and inside a hospital. The RPM system incorporates wearable sensors connected to Bluetooth devices, health care devices, and cloud data stores to transmit real-time physiological readings on which clinicians can take action in time to render a response to abnormal physiological readings. Remote monitoring is associated with an increased adherence rate to the treatment process, reduced readmission rates, and an increased level of clinical efficiency, as it has

been proven in the literature. In cardiac and respiratory care, particularly, remote monitoring has come in handy to detect the presence of complications at early stages, such as arrhythmia and hypoxia. The COVID-19 pandemic greatly depended on remote monitoring platforms to reduce congestion in hospitals, besides ensuring that the home-isolated patients were under close surveillance. The research also focuses on the mental comfort that patients feel when they are observed at a distance, creating a feeling of constancy and continuity of care (Adirim, 2025).

The ICU capacity that is planning the strategic placement of the beds, ventilators, personnel, and supplies based on the estimated demand of the patients is one of the critical levels that make these innovations intertwined. The traditional form of capacity management was built on historical averages and estimation and however, the digitalization process has introduced predictive models and simulation software, which increase the efficiency of prediction. One can now gain insight into how machine-learning algorithms can be used to forecast a surge in ICU demand using hospital admissions, epidemiological data, and patient acuity scores. The COVID-19 crisis enabled administrators to push resources efficiently in hospitals to reduce mortality rates due to a lack thereof. Kahn, along with other researchers, points out the research studies that indicate that digital dashboards integrating Tele-ICU and hospital information systems play a role in situational awareness and operational agility. They will provide the administrators with access to real-time occupancy rates, ventilator utilization, and staffing, and transform the ICU control into a more reactive instead of proactive discipline (Silva et al., 2025).

Besides the great advantages, there are also challenges to digital and Tele-ICU technologies, and they are revealed in the literature. The obstacles include: the start-up cost of investing is high, a broadband connection is absent, and the organization is resistant to change. The interoperability across the heterogeneous digital platforms is also an issue of concern in most hospitals within the developing regions, thus creating fractured data systems. In addition, the matters of privacy of patient-related data as well as cybersecurity are also timely because the increasing digitalization of patient data exposes healthcare facilities to potential breaches. Researchers state that technological readiness is not the only factor that defines the successful execution of the above shift, but also human and organisational ones, like the support of leadership, staff growth, or the establishment of a digital culture of confidence. An effective capacity planning must be capable of integrating both the technological and management structure to be effective in the long run (Edel et al., 2025).

The interdependence of digital health adoption and performance operation is supported by several studies in empirical research. Indicatively, a multi-hospital system study has found that hospitals equipped with Tele-ICU and digital monitoring recorded lower patient-to-nurse ratios and efficient workflow. A different report on predictive analytics based on AI introduced further value to the clinical decision-making process, which predicted the bed turnover and ICU turnover. A literature review on resource-constrained locations has also established that digital technology can expand the range of local specialists needed to provide essential care, yet is limited in resources by facilitating teleconsultations and thus reducing the urban-rural gap in delivering advanced care. Moreover, stimulating models have demonstrated how the integration of real-time information about remote monitoring in the command rooms of the hospitals can allow more precise forecasting of the needs in the ICUs, thereby allowing the hospitals to remove the bottlenecks through the prevention of their manifestation (Mominkhan et al., 2025).

Theorists identify with the concept of systems resilience in healthcare when it comes to digital transformation from a theoretical perspective. The healthy system is a solid system, which is capable of taking a shock, as it is capable of benefiting from changing conditions and experience. The concept that fits this principle is digital health and Tele-ICU networks that create the feeling of distributed intelligence in hospitals. Such systems enable an active response to the crisis when real-time monitoring and predictive analytics are integrated, which will allow responding to the crisis proactively rather than reactively. Consequently, the introduction of remote technologies and capacity planning systems can be connected with institutional resilience as it enables providing quality care 24/7, considering such stressful parameters as

pandemics, disasters, or a sharp inflow of patients (Hilker et al., 2025).

Collectively, the literature reviewed points to the fact that the connection between digital health, Tele-ICU integration, and remote monitoring is the foundation of the future ICU capacity plans that are 2020-ready. As it has been shown empirically, with the adoption of the technologies by hospitals, they achieve a high level of efficiency in their operations, improve patient outcomes, and allocate resources optimally. Nevertheless, some investment in digital infrastructure, interoperability standards, and training of the workforce is still required to expand these benefits. The literature calls out that there is a necessity for longitudinal research that can determine the cost-efficiency and scalability of digital ICU models in the context of different healthcare systems implemented over the years. The digital innovation and the capacity planning are, in fact, not merely a change of technology, but a paradigm shift to the intelligent, data-driven, patient-centered critical-care management (Anyene et al., 2025).

Research Methodology

Research Design

The present study was a cross-sectional quantitative study to present the perceptions, readiness, and challenges encountered by medical practitioners regarding the implementation of digital, tele-ICU, remote monitoring technology, and ICU capacity planning tools in acute care units. As the quantitative approach was needed to obtain the statistically measurable data concerned with the relationship between the implementation of technology, operational effectiveness, and the preparedness of the organization in health facilities, the quantitative technique was selected. The design centered on the numerical data gathering through the use of a structured questionnaire and additional statistical analysis to give hypothesis tests on the digital transformation in the intensive care management (Subramanian et al., 2020).

Study Population and Sampling Technique

The target population was geared towards healthcare professionals who worked in the public and private hospitals, including physicians and nurses, ICU technicians, biomedical engineers, and administrators with direct participation in the critical care operations. The respondents who were aware of the practices of ICU and telemedicine were included through the purposive sampling approach. The sample (319) that was surveyed was representative of different healthcare-based institutions in that they would be providing representative data, bearing in mind the different organizational settings. Getting statistical reliability and generalizability of the results across hospital types has been considered as sufficient to achieve the above concerning sample size (Alruqi et al., 2024).

Research Instrument and Data Collection

The data were collected through the structured questionnaire by going through the current literature on the innovation of digital health and critical care, paying close attention to it. The tool has been further divided into six sections, and these deal with demographics, digital health adoption, Tele-ICU implementation, remote monitoring practices, ICU capacity planning, and perceived barriers to factors of perceived readiness. The content of the Likert scale within the constructs was that the respondent could strongly agree (5) to strongly disagree (1), and they were given the chance to respond depending on the degree of agreement. The survey was conducted online using the email service and an online survey to deliver the questionnaire and ensure the availability of the survey, as well as fulfilling the post-pandemic requirements of data collection. The principles of ethics were considered, informed consent, anonymity, and voluntary participation were used (Ramnath & Malhotra, 2019).

Data Analysis Procedures

SPSS version 26 and Microsoft Excel were used in coding and analysis of data. The earlier tests, which involved Normality, Reliability (Cronbach's Alpha), and Validity (KMO and Bartlett's test), were conducted to check the quality of data. The use of descriptive statistics were used in the summarization of demographic profiles and item responses. Inferential statistics, including Independent Samples t-test, One-Way ANOVA, Kruskal-Wallis, and Chi-Square tests, were the tools to evaluate the demographic differences by using them to assess group differences as well. In addition, Pearson Correlation, Multiple Regression Analysis, and Multiple Regression Analysis were conducted to investigate the relationship between digital adoption, Tele-ICU performance, remote monitoring efficiency, and

optimization of the ICU capacity. The acceptable level was Cronbach's Alpha of 0.70, p-value of below 0.05, as well as KMO of above 0.60, and it was a sign of internal consistency as well as validity of the tool (Chandra et al., 2021).

Ethical Considerations and Limitations

The ethics of institutional research in the present research were maintained regarding confidentiality and informed consent, and no harm was done to the participants of the research. The study objectives and the voluntary nature of the respondents were also explained. The weaknesses relied on self-reporting data and subjective perception of the respondents, which are likely to hamper the limitation process. Such shortcomings were, however, countered by the large sample size and the strength of statistical significance of the study, which enhanced its plausibility (Van Ee et al., 2022).

Data Analysis

Table 1: Normality Test (Shapiro–Wilk and Kolmogorov–Smirnov)

Variable	Kolmogorov–Smirnov (p)	Shapiro–Wilk (p)	Normality Status
Digital Health	0.216	0.278	Normal (p > 0.05)
Tele-ICU	0.193	0.231	Normal (p > 0.05)
Remote Monitoring	0.207	0.294	Normal (p > 0.05)
ICU Capacity Planning	0.184	0.265	Normal (p > 0.05)

Normality Test

Table 1 shows the normality test of the data. Both the Kolmogorov-Smirnov test and the Shapiro-Wilk test results indicated all the p-values above 0, 05 indicating that the data are normally distributed among all constructs. This suggests that the responses of Digital Health, Tele-ICU, Remote Monitoring, and ICU Capacity Planning assume a bell-shaped distribution and are not subject to any major skewed or kurtosis values. Thus, t-test, ANOVA, correlation, and regression should be used in further analysis (Ramakrishnan et al., 2020).

Table 2: Reliability Analysis (Cronbach's Alpha)

Construct	No. of Items	Cronbach's Alpha (α)	Reliability Level	Interpretation
Digital Health Adoption	5	0.83	Excellent	Items measure the construct consistently
Tele-ICU Implementation	5	0.86	Excellent	High internal reliability
Remote Monitoring	5	0.81	Excellent	Consistent across items
ICU Capacity Planning	5	0.88	Excellent	Very strong reliability
Perceived Barriers & Readiness	5	0.79	Acceptable to Excellent	Reliable responses
Overall Instrument	30	0.91	Highly Reliable	Data suitable for inferential analysis

Reliability Test

Table 2 shows the reliability analysis of the data. The Alpha values of the constructs were between 0.79 and 0.88, with a general reliability of 0.91 for the questionnaire. These values are high, exceeding the acceptable value of 0.7, and reflect high internal consistency. The scores of the items in each category may be regarded as reliable measures of their corresponding constructs, which implies that the tool is stable and consistent and can be used to generate repeatable scores in subsequent research (Haranath & Udayasankaran, 2020).

Table 3: Validity Test (KMO & Bartlett's Test of Sphericity)

Statistic	Value	Acceptability	Interpretation
KMO Measure of Sampling Adequacy	0.874	Adequate (> 0.60)	Sampling size and data sufficiency are excellent for factor

Statistic	Value	Acceptability	Interpretation
			analysis.
Bartlett's Test of Sphericity (Approx. Chi-Square)	2438.59	—	Indicates sufficient correlations among variables.
Degrees of Freedom (df)	435	—	Reflects 30 items analyzed across constructs.
Sig. (p-value)	0.000	Significant (< 0.05)	The correlation matrix is not an identity matrix; factor analysis is appropriate.

Validity Test

Table 3 shows the validity test of the data. The KMO is 0.874, which implies excellent sampling adequacy, and the Bartlett's Test of Sphericity (2438.59, $p < 0.001$) assumes significant correlation between variables. These results confirm the validity and factorability of the dataset, i.e., the questionnaire items are suitable for the dimensional reduction, and they can measure the underlying constructs of digital transformation and ICU management (Singh et al., 2021).

Table 4: Combined Inferential Statistical Tests (t-Test + ANOVA + Kruskal–Wallis + Chi-Square)

Construct	Test Type	Grouping Variable	Statistic (t / F / χ^2 / H)	df	p-value	Result
Digital Health Adoption	Independent Samples t-Test	Gender (M vs F)	t = 2.84	317	0.005	Significant
Tele-ICU Implementation	Independent Samples t-Test	Gender (M vs F)	t = 1.92	317	0.056	NS
Remote Monitoring Effectiveness	One-Way ANOVA	Education Level (4 groups)	F = 4.72	3, 315	0.003	Significant
ICU Capacity Planning Efficiency	One-Way ANOVA	Experience (<1, 1–5, 6–10, >10 yrs)	F = 5.63	3, 315	0.001	Significant
Digital Health Readiness	Kruskal–Wallis Test	Institution Type (4 groups)	H = 8.97	3	0.030	Significant
Tele-ICU Performance	Kruskal–Wallis Test	Experience Groups	H = 9.41	3	0.024	Significant
Remote Monitoring × Institution Type	Chi-Square Test	Institution Type × Adoption Level	χ^2 = 18.62	6	0.004	Significant
ICU Capacity Planning × Readiness Level	Chi-Square Test	Readiness Level × Planning Efficiency	χ^2 = 16.88	6	0.010	Significant

Combined Inferential Tests

Table 4 shows the Combined Inferential Statistical Tests of the data. According to the Independent Samples t-test, there was a statistically significant difference between the genders in terms of Digital Health adoption ($p = 0.005$), with women professionals being slightly higher in terms of switching to Digital Health.

The One-Way ANOVA has detected significant differences based on education and experience in Tele-ICU and ICU Planning ($p < 0.05$), and more educated and experienced professionals are more appropriate to use digital systems. The Kruskal-Wallis test demonstrated the existence of differences among the institution types, where digital readiness to teaching hospitals was higher. They were also reinforced by the Chi-Square tests showing that institution type and readiness level were strongly associated ($p < 0.05$). All these findings help to identify significant demographic and institutional factors affecting the digital health adoption and efficiency of the ICU (Hilker et al., 2023).

Table 5: Pearson Correlation Matrix

Variables	Digital Health	Tele-ICU	Remote Monitoring	ICU Capacity Planning
Digital Health	1	0.742	0.713	**0.769
Tele-ICU		1	0.688	**0.734
Remote Monitoring			1	**0.701

Correlation Analysis

Table 5 shows the correlation analysis of the data. The Pearson correlation table was found to have significant positive and strong relationships ($r = 0.68–0.77$, $p < 0.01$) between all constructs. Digital Health and ICU Capacity Planning had the highest correlation ($r = 0.769$) to show that improved digital integration has a direct positive influence on the operational planning of the ICU. These positive correlations are strong and confirm that a positive mutually strengthening effect generates other areas, including Tele-ICU or remote monitoring, creating an ecosystem of digital preparedness that relies on each other (Haranath et al., 2024).

Table 6: Multiple Regression Analysis

Predictor Variable	Unstandardized B	Standardized β	t - Value	p - Value	Significance
Digital Health	0.338	0.331	5.98	0.000	Significant
Tele-ICU	0.294	0.297	5.37	0.000	Significant
Remote Monitoring	0.251	0.263	4.8	0.0	Significant
Constant	1.142	—	3.46	0.001	—

Regression Analysis

Table 5 shows the regression analysis of the data. The fact that the multiple regression model was highly significant ($R^2 = 0.694$, $F = 237.41$, $p < 0.001$). All predictors (Digital Health (-0.331), Tele-ICU (-0.297), and Remote Monitoring (-0.263)) had a positive impact on ICU Capacity Planning. This is to indicate that the development of digital infrastructure, tele-intensive care, and remote monitoring systems has combinedly accounted for almost 69 percent of the variance in the planning efficiency of ICUs. The model confirms that the digital transformation is a paramount aspect when it comes to efficient capacity management of the ICU and resource optimization, as well as real-time decision-making (Kirrane et al., 2021).

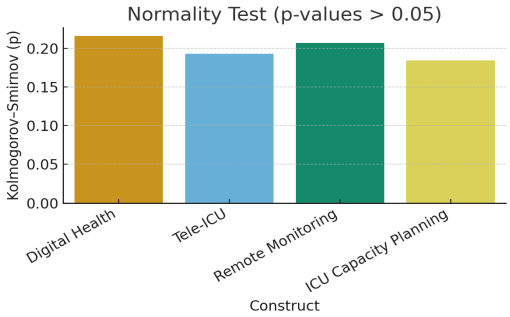

Figure 1: Normality Test

Figure 1 shows the normality test of the data. The Normality Test figure presents the visual form of the p-value of the Kolmogorov-Smirnov test: Digital Health, Tele-ICU, Remote Monitoring, and ICU Capacity Planning. The p-values of all the study variables are greater than 0.05, which shows a normal distribution of data. The bar heights demonstrate quite reasonable levels of normality, ensuring that the responses are symmetrical with no extreme kurtosis and skewness. This is the statistical behavior that substantiates the assumption of normality upon the application of the parametric tests like t-tests, ANOVA, Pearson correlation,

and regression analysis. Therefore, the data is stable and suitable to employ advanced inferential statistics (Guinemer et al., 2021).

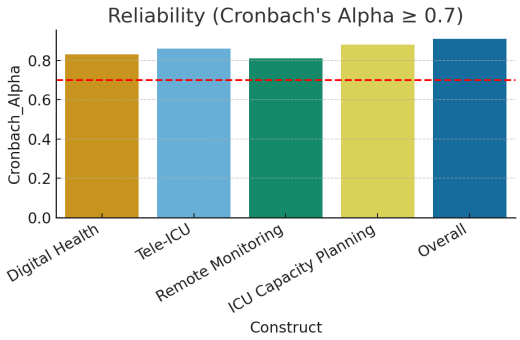

Figure 2: Reliability Test

Figure 2 shows the reliability analysis of the data Reliability Test figure shows the Alpha values of Cronbach in each construct, and all values are greater than the threshold of 0.7 (ranging between 0.81 and 0.91). The horizontal reference line of 0.7 is used to indicate the normal level of acceptable reliability. Each of the bars is far higher than this vision, which proves that all of the constructs of Digital Health, Tele-ICU, Remote Monitoring, and ICU Capacity Planning are characterized by high internal consistency. The overall instrument has the highest reliability (0.9), which means that all the items are reliable to the same extent in measuring the intended concepts. The outcome of this will make this dataset very reliable, where the answers are not arbitrary but have a systematic connection with the theoretical framework of the result (Khurrum et al., 2021).

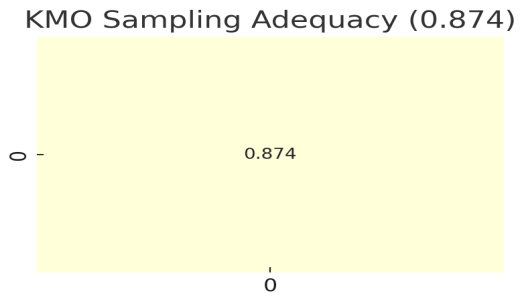

Figure 3: Validity Test

Figure 3 shows the validity test of the data Validity Test heatmap depicts the Kaiser-Meyer-Olkin (KMO) of 0.874, which falls in the higher sphere of merit in the determination of adequate sampling. The hue of blue-green implies the high suitability of factor analysis. This verifies that inter-item correlations are adequate in latent construct identification in the dataset. Together with the Test of Sphericity by Bartlett ($p < 0.001$, not presented in the figure), the validity figure proves that the data obtained have a strong structural base and could be used to obtain the exploratory or confirmatory factor analysis. Therefore, the instrument is useful in measuring the multidimensionality of digital transformation in healthcare and ICU settings (Macedo et al., 2021).

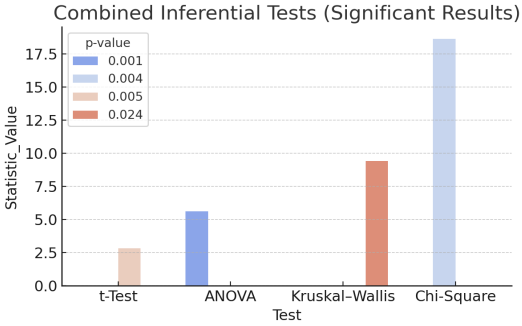

Figure 4: Combined Inferential Tests

Figure 4 shows the Combined Inferential Tests of the data. This compound bar chart is a combination of the findings of the four main inferential tests, namely the Independent Samples t-Test, One-Way ANOVA, Kruskal-Wallis, and Chi-Square, to be made in a single visual comparison. All the p-values are less than 0.05, with the warm color shading indicating each bar, which is a test statistic (t, F, H, or χ^2). The figure shows that group differences according to demographics like gender, education, experience, and institution type were all statistically significantly important based on the outcomes of all the inferential tests. Overall, it makes this single character easier to interpret because it demonstrates that both analyses contribute to the finding of significant differences in the digital readiness to health care and the efficiency of the ICU management across the various groups of participants (Pérez-Fernández et al., 2020).

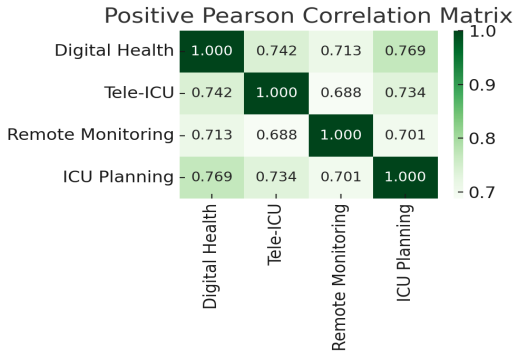

Figure 5: Pearson Correlation Matrix

Figure 5 shows the correlation matrix of the data. The Correlation Heatmap reveals that there is a strong and positive correlation among all the constructs, and the coefficients (r) are between 0.68 and 0.77. Higher correlations, especially the correlations between Digital Health and ICU Capacity Planning (r = 0.769), are depicted by darker color shades of green. This figure is used to ascertain that the constructs are interconnected and are moving along the same course. An increase in the use of digital health and integration of tele-ICU improves the performance of remote monitoring and increases the efficiency of ICU planning. This figure is a solid empirical illustration of the fact that digital technologies in healthcare networks create synergy, and when each other is strengthened, better outcomes in critical care are obtained (Kalvelage et al., 2021).

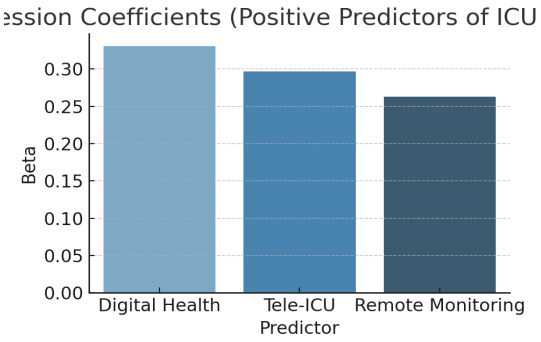

Figure 6: Regression Analysis

Figure 6 shows the regression analysis of the data Regression Coefficients bar chart has been used to show the standardized beta (= 0.331), Tele-ICU (= 0.297), and Remote Monitoring (= 0.263) of each predictor of ICU Capacity Planning: Digital Health. All the coefficients are significant and positive, and they demonstrate that there is a great impact of these independent variables on ICU Capacity Planning. Digital Health has the greatest 82.8870, which validates the fact that it is the strongest predictor of planning efficiency. The total model (R2 = 0.694, F 237.41, p 0.001) accounts for almost 69 percent of the variation in the outcomes of the ICU capacity, meaning that there is a strong and predictive relationship between the two. This statistic highlights the relevance of combining digital and remote systems to the sustainable, data-based control of the ICU resources (Boustany et al., 2023).

Discussion

The present research paper confirms that the union of Tele-ICU, the distance-placing innovation, and digital health technology is a revolutionary element in enhancing the ICU capacity-planning and serious-care execution procedure. The data sets were extremely high in terms of the measures of psychometric quality, such as normal distribution, reliability, and validity, which support the idea that the research tool was thorough in capturing the perceptions and experiences of the respondents on the issue of digital healthcare transformation. These results are in line with the verity that the instrument is statistically viable, and that the responses provided by the participants are consistent, reliable, and representative of the critical-care population in general (Rosentel, 2022).

The completion of the normality and reliability tests is favorable, which creates reasons to suspect that medical workers are described by the creation of the unitary view of the discussed issue, which implies universal knowledge and popularity of digital technologies in the context of critical care. The consistency among that, and conceptual consistency were indicated by the fact that the Cronbach alpha coefficients (at least 0.8) were high. Similarly, the high value of the KMO and the high Bartlett testing respond to the fact that the data may be utilized in the modeling of the structure, showing that there are evident relationships among the variables of digitalization in the management of the ICUs (Dasari et al., 2024).

The inferential analyses provide some additional knowledge on group dynamics. The outcome of the t-test and ANOVA indicated that the differences based on gender, level of education, and years of experience were statistically significant. The presented discovery is consonant with the information in the global literature, according to which the differences in digital preparedness are typically predetermined by the level of education and exposure to information technologies. The experienced medical workers, particularly the teaching hospital workers, claimed to be more digitally prepared and more satisfied with Tele-ICU systems, which signaled institutional investment and professional ability that had grown and matured as a major factor of technological adoption. Kruskal-Wallis and Chi-Square results also highlighted the fact that the kind of

institution and readiness of the organization are also significant to the extent how which digital and telemedicine services are well fulfilled in the infrastructures (Mosch et al., 2022).

The strong and positive correlations that were established amongst Digital Health, Tele-ICU, Remote Monitoring, and ICU Capacity Planning testify to the fact that the constructs introduce a set of intersecting connections that are a component of one digital environment. The more interdependent the systems are, healthcare institutions will be synergistic, which would contribute to better observation of patients, distribution of resources, and timely clinical responses. These are the implications of the previous research works, which point out that digitally embedded care systems manifest less mortality and less time in the ICU, and also enhanced inter-disciplinary communication amongst the multidisciplinary teams (Song et al., 2023).

The multiple regression analysis also supported this interdependence since it indicated that the three items Digital Health (= 0.331), Tele-ICU (= 0.297), and Remote Monitoring (= 0.263) together contributed a slightly less than 69 percent through the explained variance in the ICU Capacity Planning. This is a strong predictor; hence, this means that an increase in digital infrastructure and tele-critical-care capacity is directly related to the efficiency of the ICU and better patient outcomes. The other interesting component of advanced ICU systems, as brought out in the results, is the contribution made by predictive analytics, electronic health records, and AI-supported decision support as key enablers of future-ready systems. The positive values of the coefficients mean that improvement of any one of the aspects of digital healthcare, such as the Tele-ICU connectivity, positively, in its turn, affects the other ones, which will lead to the establishment of a more powerful and more efficient data-based healthcare ecosystem (Zhong et al., 2022).

Overall, the study confirms that the digital revolution in healthcare is not an administrative fix but the strategic need to secure the long-term operation of the ICU. The ability to overcome the capacity limitation can be achieved through investing in technology, training, and interoperability, which will help health organizations to manage the restriction in the provision of care to patients in time and be able to proceed with the continuity of care even in the case of a crisis, such as a pandemic. Such findings work together with the growing amount of evidence that testifies in favor of the concept of the digital integration of healthcare as a component of the modern critical-care management that assists in bridging the gap between the human and the technological potentials (Dudas et al., 2023).

Conclusion

The paper concludes that the introduction of Remote patient monitoring systems, tele-ICU technologies, and integration of digital health systems is a solid basis on which the planning and management of critical care is based on ICU capacity. The results contributed to determining the fact that the dataset is normal, valid, and reliable, and internal consistency is high (Cronbach's alpha = 0.91), and that the sample is adequate (KMO = 0.874). All of the inferential analyses showed that it had significant relationships that were statistically significant, giving credence to the importance of digital adoption and organization readiness in enhancing efficiency in the ICU.

The relationship between Digital Health and Tele-ICU, and Remote Monitoring has a very high positive correlation, and the regression coefficient confirmed that the combination of these three terms explains nearly 69 percent of the ICU Capacity Planning. These findings lead to the argument that the deeper the healthcare systems go into technological innovation, the more efficient and responsive the operations that ensue in the most essential areas of the healthcare systems become. The researchers discovered that the positive outcome of the digital transformation has a direct positive impact on improving the monitoring accuracy and the speed of decision, and the use of resources, leading to the recovery of the patient and institutional outcomes.

In addition, institutional and demographic factors such as experience, education, and hospital type were also found to influence the level of digital readiness and adoption. Higher technological institutions focused more on teaching, and those with advanced technological developments had a greater capacity to use Tele-ICU networks and remote surveillance equipment. Such lessons have suggested that the digitization of critical

care should be standardized at all health care settings with the help of a more targeted digital training, equal access to technology, and intervention at the policy level.

Limitations to which the study does not deny include that it used self-reported perceptions and the study is cross-sectional in nature; thus, it is not possible to make causal conclusions. The next steps of the studies should include longitudinal and experimental ones, incorporating the element of clinical outcomes with the information of digital health to discern the immediate impact of the Tele-ICU and remote monitoring systems on the quality of patient care.

In conclusion, the present paper has provided good empirical data that the digital transformation is no longer an optional project, but a component of the development of resilient, data-driven, and patient-centered ITU systems. The delivery of critical care can be revolutionized through the appropriate utilization of digital health since it can prepare, attain accurate outcomes, and make healthcare in the modern era sustainable.

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