The Role of Intellectual Capital on Hospital Performance: Evidence at Facility-Level

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Based on the social capital theory, this study argues that intellectual capital, defined as knowledge and capabilities within the organization, significantly affect hospital performance. This study examines the impact of intellectual capital on four key hospitals' performance metrics, i.e. quality, productivity, length of stay, and satisfaction. Using a sample of 34 hospital facilities' operational reports to construct hospital performance and individual-level survey of 143 individuals across these 34 facilities to construct intellectual capital during 2018, this study finds that intellectual capital significantly increases employee productivity and reduces patient stay length. This study contributes to the literature by providing evidence that intellectual capital plays an important role in reducing bottleneck for hospitals to meet increasing demand in healthcare services.

Keywords: social capital theory, intellectual capital, organizational performance, hospital performance, healthcare

INTRODUCTION

The percentage of aging population in the United States has increased rapidly in the past century (Neal & Maniram, 2022). According to the U.S. Bureau of Census, one out of six people in the U.S. were 65 years or older during 2020 compared to less than one out of 20 people in 1920 (Caplan, 2020). Despite the Covid-19 pandemic, public health care spending in the U.S. reached $4.2 trillion, representing 18.3% of the U.S. gross domestic product (GDP) - the highest percentage in our history (CMS, 2021). The United States spends more on health care costs per capita than every other country in the Organization for Economic Cooperation and Development (OECD, 2022). Limited hospitals' capacities have been identified as a bottleneck during unexpected recent Covid-19 pandemic to provide healthcare services at the time needed

(Ardebili et al., 2021; Capolongo et al., 2020). Therefore, efficiencies and organizational performance in a hospital setting have become a topical public health issue recently (e.g., Amer et al., 2022; Shahverdi et al., 2023).

Extant literature that examines organizational performance in a hospital setting has mostly focuses on the use of technology to enhance healthcare quality (Grosskopf & Valdmanis, 1987; Groene et al., 2008). While advancement in technology is critical in a hospital setting, recent studies argue that the human element and intellectual capital, i.e., knowing what to do at the time where patients' lives are at stake, also play important roles to improve hospital performance (Chen, 2021; Sarto & Veronesi, 2016). Hence, the purpose of this study is to examine the role of hospitals' intellectual capital from the hospitals' employees on four key performance indicators (KPIs): hospital quality, employee productivity, patients' average length of stay, and patients' satisfaction.

We collected our data from hospital operational reports across 34 hospital facilities and 143 individual-level survey responses from employees who worked on these 34 hospital facilities to examine the relationship between intellectual capital and four hospitals' KPIs. After compiling our data and conducting our empirical analysis using the multivariate regression analysis, we find evidence that intellectual capital improves hospitals' performance, specifically in terms of shorter patients' length of stay and higher employee productivity. Our findings provide important public health policy implication by highlighting the importance of intellectual capital to improve the efficiency, i.e., patients' length of stay, and employee productivity, which are crucial factors to increase the hospital capacities to provide healthcare services for increasing percentage of aging population and to withstand the unanticipated global pandemic (Amer et al., 2022; Shahverdi et al., 2023).

This paper is structured as the followings. The next section discusses the relevant literature review and our hypotheses. Then, we discuss about data collection process. Next, we present our sample statistics and discuss the multivariate regression results. Finally, we close our study with a conclusion and a recommendation for future studies.

LITERATURE REVIEW

Nahapiet and Ghoshal (1998) define intellectual capital as "the knowledge and knowing capability of a social collectivity such as an organization, intellectual community, or professional practice," (p. 245) and that the coevolution of these two types of capital serves as a causal basis for the development of organizational advantage. Similar to the construct of social capital, intellectual capital has been conceptualized in different ways. Using systematic literature review, Inkinen (2015) identifies nine concepts that have been utilized to represent intellectual capital: human capital, structural capital, relational capital, organizational capital, social capital, customer capital, innovation capital, information capital, and technological capital.

We explain our rationale to choose our four KPIs as the followings. First, to standardize quality reporting across hospitals, in 1999 the Joint Commission for Accreditation of Hospital Organizations (JCAHO) as an accreditation body for all hospitals in the U.S. began the work of developing core quality metrics and in 2003 hospital quality standards were published nationally across the United States health care system (JCAHO, 2018). We examine *hospital quality* as a performance outcome variable because it is a standard key operational performance metric that each hospital must report to the JCAHO.

Second, given the multiple economic pressures that hospitals and health systems face, labor efficiency is important to operational executives in the health care industry. Managers in health care environments are under pressure to use several different approaches to increase productivity such as organizational redesign, integration of services, and process engineering. While hospital executives continue to push for higher productivity, the result is often not positive with staff. For example, a study of 319 nurses working across 303 hospitals revealed high levels of job dissatisfaction, burnout, and concerns over the ability to provide quality care (Aiken, Clarke, & Sloane, 2002). Tools that can be leveraged to make productivity easier may help ease the burden on care providers in hospital settings. Although information technology aspires to be a productivity tool, many health care studies suggest that it can negatively impact provider productivity

(Jha et al., 2009; Rau, 2011; Simon et al., 2007). Employee productivity was selected as a performance outcome in this study because productivity is reported out monthly as a key operational metric by the hospital system.

Hospital length of stay is considered the top key performance to evaluate overall efficiency within a hospital under the rationale that a shorter stay is a sign of better care that will result in reduced overall costs and better outcomes (OECD, 2017). Moreover, since the advent of the Prospective Payment System (PPS) in the 1980s hospitals have been financially incentivized to reduce inpatient length of stay by receiving fixed fee payments per diagnosis. Accordingly, the average hospital length of stay for patients 65 and over in the United States has dropped from 10.7 days in 1980 to 5.5 days in 2010 (Kozak, Lees, & DeFrances, 2006; US Department of Health and Human Services, 2010a). However, this metric is not without controversy as shorter length of stay has also been correlated with higher risk for readmission and 30-day mortality rates (Cutler, 1995; Gilbert, 2015; Heggestad, 2002; Southern & Arnsten, 2015). Nevertheless, for the purpose of this study length of stay was selected as an outcome measure because it remains an important performance indicator for hospital leaders and because it is specifically reported out monthly as a key operational metric by the hospital system.

The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey was developed in partnership between the Centers for Medicare & Medicaid Services (CMS) and the Agency for Healthcare Research and Quality (AHRQ) (CMS, 2021). The HCAHPS Survey, which is administered to a random sample of patients continuously, provides a standardized methodology for collecting data about patients' perspectives on hospital care. CMS has been publishing patient satisfaction scores on its hospital compare website since 2008. In 2012, CMS began using these scores to adjust hospital payments as part of its Value-Based Purchasing Program (Rau, 2011). There are two global questions on the HCAHPS Survey: overall hospital rating and willingness to recommend the hospital. For this study, the willingness to recommend score was selected as an outcome variable because it is reported monthly as a key operational metric by the hospital system.

We discuss the literature on intellectual capital that are closely related to our four KPIs measures. First, since healthcare and hospital services are labor-intensive services, we specifically focus on the human capital as our measure of intellectual capital. Inkinen (2015) defines *human capital* as the intelligence of the organizational member, which contains features such as the employees' sheer intelligence, values, attitudes, aptitudes, know-how, skills, capabilities, individual relationships, creativity, education, experience, qualifications, motivation, commitment, loyalty, resolve, interactions, expertise, proactivity, leadership abilities, flexibility, learning capacity, behavior, intellectual agility and risk-taking propensity. Paoloni et al. (2020) and Schiavone (2022) argue that human capital is one of the critical elements of intellectual capital that is still under-researched in the healthcare industry.

Second, our KPI also focuses on how the organizational structure could influence employee productivity. Inkinen (2015) defines *structural capital* as organizational factors that support the human capital to perform including elements such as employee-supporting mechanisms and structures, organizational know-how, routines, procedures and processes, corporate culture, methods, business development plans, intellectual property, strategy, organizational charts, manuals and programs. Third, customers play a significant role on the hospital setting since hospitals provide health services to their customers. Hence, we follow Inkinen (2015) and focus on *customer capital, i.e., t*he valuable knowledge embedded in customer relationships and marketing channels, originating from customer-supplier relationships, which conceptually also overlap with relational capital. Paoloni et al. (2020) highlight the importance of structural, relational, and customer capital in the healthcare sector.

Finally, innovations and finding new ways to improve in the hospital setting. Based on Inkinen's (2015) *innovation capital, i.e.,* the ability to utilize existing knowledge to create new knowledge, ideas, products, and technologies. Ozgun et al. (2022) find that innovation capital plays an important mediating role on organizations' intellectual capital and performance in the healthcare industry. Thus, we examine our fourth KPI on the ability for a hospital facility to discover new ways to be a better hospital as a measure of innovation capital.

Based on Nahapiet and Ghoshal (1998), the operational definition of intellectual capital is “the knowledge and knowing capability of a social collectivity, such as an organization, intellectual community, or professional practice” (Nahapiet & Ghoshal, 1998, p. 245). In their discussion about the conceptual formation of this intellectual capital construct, Nahapiet and Ghoshal (1998) covered two key concepts. The first was the debate regarding the types of knowledge that may exist, specifically tacit and explicit. Acknowledging Polanyi (1964) for developing the most cited and influential distinction between tacit and explicit forms of knowledge, Nahapiet and Ghoshal (1998) aligned with the concept that there is a difference between explicit knowledge (e.g., understanding of facts, figures, information) and tacit know-how, which they also referred to as “knowing as action or enactment” (p. 246). Both forms of knowledge were incorporated into the adopted definition of intellectual capital. Notably, the concept of tacit knowledge is also central to situated learning and cognition which was instrumental in the development of Brown and Duguid’s (1989) communities of practice theoretical framework.

The second concept that Nahapiet and Ghoshal (1998) addressed was whether collective knowledge and knowing capability exists as anything more than the aggregation of individual knowledge and knowing capability. In the context of social capital research, the authors suggested that the key question is whether or not it is possible to consider collective knowledge as part of the model. While acknowledging both sides of this argument, they concluded that their conceptualization of intellectual capital embraces the idea that knowledge and knowing can and does exist within the social fabric of a collectivity in a way that differs from “the simple aggregation of the knowledge of a set of individuals” (p. 246). In reaching this conclusion, the authors cited communities of practice theory as introduced by Brown and Duguid (1991) in which shared learning occurs through constructivism within a complex social network. While acknowledging the existence of both individual and social knowledge, Nahapiet and Ghoshal (1998) ultimately determined that the social form (both tacit and explicit) should be the focus of their social capital model as it would more likely serve as a potential source of organizational advantage.

Further developing the construct of intellectual capital, Nahapiet and Ghoshal (1998) suggested that knowledge is created through two basic processes: combination and exchange. Combination refers to the concept that separate sources of knowledge and knowing capability can be merged and leveraged in new and different ways (either through new connections or reconfiguration). This can result in both incremental, step-wise learning and more radical, innovative learning. This distinction is commonly understood using the concepts of single versus double-loop learning as introduced by Argyris and Schon (1978). Exchange, specifically the exchange of knowledge and knowing capability, is a prerequisite for combination. While this does, of course, occur through the explicit sharing of knowledge, within the paradigm of social constructivist learning that lies at the foundation of social capital research and communities of practice, the knowledge creation that occurs tacitly through social interaction becomes of particular interest. A detailed review of knowledge and learning is beyond the scope of this dissertation. However, the relevant notion here is that intellectual capital exists as a function of complex social interactions within a community of practice and that such intellectual capital can serve as a potential form of increased organizational performance and competitive advantage. Turner (2011) find evidence to support the relationship between intellectual capital and organizational performance and the organizational benefits of social capital (Karahanna & Preston, 2013; Tsai & Ghoshal, 1998; Wagner et al., 2014).

Based on the above literature, we expect that greater intellectual capital would lead to higher hospital quality measure and employee productivity. We also expect that greater intellectual capital leads to lower hospital stays as patients are expected to be able to recover sooner under greater intellectual capital. Finally, we expect that higher intellectual capital would result in higher patients’ satisfaction rate over the health services they have received from the hospital. Thus, our four hypotheses are formally stated as the followings:

H1: *There is a positive relationship between intellectual capital and hospital quality*

H2: *There is a positive relationship between intellectual capital and employee productivity*

H3: *There is a negative relationship between intellectual capital and patient length of stay*

H4: *There is a positive relationship between intellectual capital and patient satisfaction*

DATA AND SAMPLE

We test our hypotheses by collecting the intellectual capital at the individual-level each hospital facility and aggregated into an intellectual capital measure at the hospital facility level. The performance outcomes are collected from each hospital facility's reports. Because the hospital serves as the organizational-level business unit in a health care enterprise, the aggregation of individual-level into an organizational-level data allows for comparison of outcome data, it was the appropriate level at which to test the proposition that increased intellectual capital would be correlated with performance outcomes.

The sample frame for this study was drawn from 34 acute care hospital facilities geographically divided into eight hospital facilities service areas: Arizona, Nevada, and six in California: Greater Sacramento, Bay Area, Central California, Central Coast, North State, and Southern California. These 34 hospitals are supported by a total of approximately 150 IT field service operations (FSO) team members. FSO team members are those IT employees who provide on-site support to acute care facilities and employees. As the "front line" of IT support, FSO staff have the most face time with on-site acute care facility workers and thus are best positioned to evaluate the quality of relationships and conditions within their facilities.

A total-population sampling approach was used. Total-population sampling is a form of purposive sampling where participants are selected because of their specific ability to provide answers to the questions being investigated (Etikan, Musa, & Alkassim, 2016). This approach is more commonly used in circumstances where the total number of cases being investigated is relatively small. In this case, the researcher worked with the managerial leader of the IT field service employees to administer the survey to all 150 field service workers who provide services at hospital facilities within the health care system that was chosen for this study. Thus, the IT field service employees served as the population and sample for individual level variables. The 143 individual respondents used on this study varied about age (ranging from 20s to 60s) and education (ranging from an associate's to master's degree in IT or a related field). Similarly, total-population sampling was used for facility-level variables, with all of the 34 available facilities included in the study.

Human Subjects Protections

Based on the following factors, this non-experimental study qualified for exempt Institutional Review Board (IRB) review as defined under HHS regulation 45 CFR 46.110 (US Department of Health and Human Services, 2010b): no participants were under the age of 18, no interaction with the researcher was required, the study proposed less than minimal risk to participants, and the study included no sensitive data or quasi-protected populations. We obtain the IRB from our education institution in collaboration with a research coordinator from the health care organization's research institute; permission to survey the IT field service employees was obtained through the organization's formal IRB review and departmental approval process.

The risks of participating in this study were minimal, including distraction from other work duties and minor fatigue while completing the survey. Participating in this study offered no direct benefits. Indirectly the results of this study may serve to provide guidance for organizational leaders that ultimately improves the organizational culture and daily working conditions for participants and their peers. No remuneration was offered for participation in this study. Although no conflicts of interest exist (financial or otherwise), full disclosure requires noting that the researcher has been an employee of the organization used for this study for 17 years.

Measures

The following measures were utilized to collect data for this study. For convenience and efficiency all survey questions were consolidated and administered as a single online instrument using tools available through surveymonkey.com. Intellectual capital was measured via electronic survey using questions adapted from the instrument developed and validated by Turner (2011). The survey questionnaire is presented in the Appendix. The four KPIs performance, hospital quality, employee productivity, length of stay, and patient satisfaction, were measured using extant data from hospital facility-based operational reports. Table 1 shows a summary of facility-level performance variables.

TABLE 1
SUMMARY OF FACILITY-LEVEL PERFORMANCE OUTCOME VARIABLES

Variable	Type	Measurement Type	Definition
Hospital quality	DV	Interval/Ratio	This is a facility-based percentile score taken from quality survey results that ranges from 0% to 100%. Higher percentages imply higher hospital quality.
Employee productivity	DV	Interval/Ratio	This is a facility-based percentile score for employee productivity that ranges from 0% to 100%. Higher percentages imply greater employee productivity.
Length of stay	DV	Interval/Ratio	This is a facility-based numeric score for average length of stay for Medicare patients. In terms of organizational performance, a lower length of stay is more desirable.
Patient satisfaction	DV	Interval/Ratio	This is a facility-based numeric score for patient satisfaction based on HCAHPS scores ranging from 0 to 100. A higher number implies greater patient satisfaction.

DV= dependent variable. HCAHPS=Hospital Consumer Assessment of Health Plans Survey.

Data Collection Procedure

After receiving approval from the education institution's IRB and the health care organization's IRB, research institute, and executive leadership, data for intellectual capital variables was collected via an anonymous electronic survey sent via email to employees of 34 hospital facilities. To ensure a higher response rate, the Senior Director who oversees all respondents, sent the recruitment email and encouraged voluntary participation. Verbal comments from the Senior Director at departmental staff meetings and the email sent with the survey link conveyed the study's voluntary and confidential nature. They included a description of the purpose of this study. Participants had the ability to decline participation by not following the survey link provided. The email also included basic contact information for the researchers' names, email addresses, and mobile phone numbers.

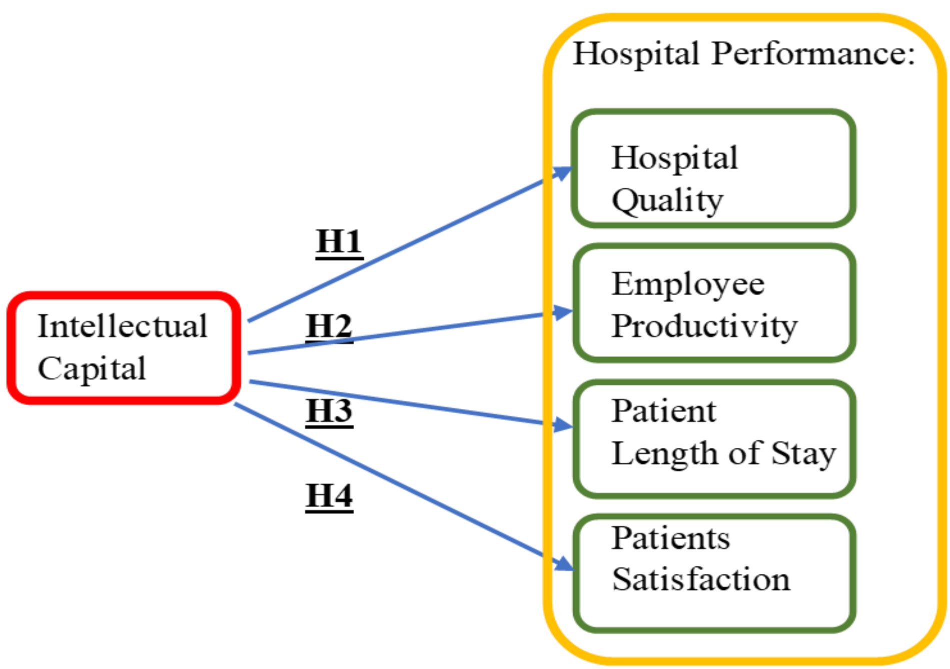
The electronic survey was developed in Survey Monkey and was configured to ensure no personally identifiable information (including IP address) was collected. The survey asked only for each respondent's personal perception and basic demographics, including gender, age (range), level of education, years spent in their current role, and years of service at the organization. The purpose for collecting these anonymous demographics was to allow for the control of covariates during data analysis. All survey data was protected by the researcher's log-in credentials to the Survey Monkey website and was deleted once the study results were finalized. Facility-level outcome data was collected from standard operational reports made available to the researcher by the healthcare system leadership.

Data Analysis Methodologies

The data was first prepared by screening out invalid case and missing value analyses. The total number of complete, usable surveys collected from individuals was 143. In addition, outcomes data was collected from a total of 34 hospitals. The univariate assumption of normality was tested for all continuous study variables so that valid inferences regarding the results of this analysis could be made. Violations of normality were tested using histograms, pp-plots, qq-plots, skew and kurtosis z-statistics and Shapiro-Wilks and Kolmogorov-Smirnov statistical normality tests. Extreme outliers were also assessed and winsorized. Reliability testing was completed to ensure all computed continuous subscales had sufficient internal consistency and inter-item correlation was conducted. All of the subscales had strong Cronbach's alpha values ($\alpha > .8$). Lastly, all categorical variables were assessed to ensure that group levels had sufficient proportions (at least 10% of the sample) within each level in order to properly conduct parametric analysis for this study (Field, 2009; Tabachnick & Fidell, 2007). The pre-analysis assumptions testing revealed that there were minimal problems regarding univariate normality of the continuous study variables, there were no extreme outliers present in the data nor issues with skewness or kurtosis. Only one variable, the hospital quality metric, failed the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality. However, bootstrapped confidence intervals were conducted to address this (in addition to mitigating the effect of the small sample size). At the individual level, the only categorical variable that did not have sufficient sample within its levels was education, where there only 2.1% and 0.7% of the sample had a master's or a doctoral degree, respectively. Both levels were combined into a graduate degree category; ultimately, this did not prove to be an issue in estimation. In addition, the number of female participants was low (8.4%), but within tolerable limits. After data preparation was complete, it was observed that out of the final sample of 362 observations there were no missing values in the overall dataset. With no missing data, a missing value assessment was not conducted and Little's MCAR test (Little, 1988) was not administered. This was true for both the individual and hospital level data.

Since we measure performance at the hospital-level, individual-level intellectual capital was aggregated by hospital and used as the independent variable in ordinary least squares and multivariate linear regression analysis to evaluate correlations with four hospital level dependent variables: hospital quality, employee productivity, length of stay, and patient satisfaction. IBM SPSS AMOS v.25 was used for this analysis and our four hypotheses tested are shown in Figure 1. Higher scores indicated higher values of these organizational metrics for hospital quality, employee productivity, and patient satisfaction. For length of stay, a lower score was more desirable.

FIGURE 1
THE IMPACT OF INTELLECTUAL CAPITAL ON HOSPITAL PERFORMANCE



Aggregating the individual intellectual capital scores by facility-level was necessary because the outcome variables were only available at the hospital facility-level. This aggregation was conceptually justifiable considering that each respondent was asked to score their perception of intellectual capital at an overall facility rather than an interpersonal level. We evaluate the correlations between intellectual capital and performance outcomes and the ordinary least square regression to test our four hypotheses.

A priori power analysis using a medium effect size of f2 = 0.15, a power level of 0.8, and alpha of 0.05, suggested a minimum required sample size of 54 in a model with a single predictor (in this case, Intellectual Capital) (Soper, 2018). Specific to OLS linear regression, a priori power analysis using G*Power v3.1.9.2 for a medium effect size f2 = 0.15, power of 0.80, and an alpha of 0.05, the recommended minimum sample size was 55 (Faul, Erdfelder, Buchner, & Lang, 2009). The same analysis using a Bonferroni corrected alpha of 0.0125 resulted in a minimum recommended sample size of 78. Specific to multivariate linear regression, a priori power analysis using G*Power v3.1.9.2 for a medium effect size of f2 = 0.15, power of 0.80, and an alpha of 0.05, gave a minimum recommended sample size of 85. Because the available sample size of $N = 34$ was less than the recommended sample size based on the a priori analyses, results from both the multivariate and the OLS linear regression analyses in this study are also interpreted cautiously.

Although a facility-level aggregate of the intellectual capital variable used in SEM was used as the predictor in the second step linear regression analyses, a simultaneous analysis of the complete end-to-end model was not performed. This was due to a lack of individual level scoring on the outcome measures. In essence, outcomes could not be disaggregated nor connected to the independent variables because the independent variables were measured on individuals within facilities and the outcomes were measured on facilities only.

Using the intellectual capital score aggregated by facility as the independent variable, all four performance outcomes were analyzed individually using OLS linear regression with a Bonferroni correction adjustment applied to significance testing to account for multiple independent hypothesis tests (Dunn, 1961). Bias-corrected bootstrapped confidence intervals were employed to mitigate any remaining concerns about parametric assumptions in this relatively small sample size. Bootstrapping statistical methods iteratively sample the observed data with replacement to build a distribution of estimates. This process provides a means of accounting for the distortions that are caused by a small sample size (Hesterberg, Moore, Monaghan, Clipson, & Epstein, 2005) and results in robust estimates of the coefficient standard errors and confidence intervals, accounting for bias. In turn, this aids in more valid hypothesis testing and inference.

As a generalized linear modeling technique, multivariate linear regression may be used to evaluate the relationship between one or more explanatory variables and one or more outcome variables recorded on at least an interval scale (Afifi, Clark, & May, 2004). The advantage of using multivariate analysis over Ordinary Least Squares (OLS) linear regression is that this procedure controls for the effects of all four regressions simultaneously, adjusting for bias and reducing the likelihood of committing Type II errors (Afifi, Clark, and May 2004).

TABLE 2
DESCRIPTIVE STATISTICS

Variable	*N*	*M*	*SD*	*Min*	*Max*
Quality	34	56.90	8.91	39.20	83.40
Productivity	34	1.00	0.03	0.95	1.06
Length of stay	34	4.41	0.54	3.22	5.61
Satisfaction	34	56.28	20.21	12.20	95.00
Intellectual capital	34	2.89	0.38	2.00	4.00

SAMPLE STATISTICS

Hospital-level descriptive statistics for continuous study variables are presented in Table 2. Hospital quality mean scores is 56.9 with a standard deviation of 8.91. Employee productivity average scores is 1.00 with a standard deviation of 0.59. The average patient length of stay scores is 4.41 with a standard deviation of 0.54 and the average patient satisfaction scores of 56.28, a standard deviation of 20.21. The intellectual, social capital average score is 2.89 with a standard deviation of 0.38.

TABLE 3
COEFFICIENTS OF CORRELATION

Variable	Quality	Productivity	Length of stay	Satisfaction
Productivity	0.188			
Length of stay	-0.597 **	-0.171		
Satisfaction	0.026	0.303	0.002	
Intellectual capital	0.121	0.381 *	-0.243	-0.021

* and ** represent statistically significant at 5% and 1% levels.

Table 3 shows the correlation coefficients among variables used in our empirical analysis. There was a negative correlation between hospital quality and length of stay (r = -0.597, p < 0.001), indicating that as levels of hospital quality increase, length of stay decreases. In addition, we find a positive correlation between intellectual capital and productivity (r = 0.381, p < 0.05), indicating that productivity increases as levels of intellectual capital increase. Neither of these results exceeded the limit of 0.80 as Tabachnick and Fidell (2007) suggested when testing for multicollinearity. The ordinary least squares (OLS) was conducted to test our four hypotheses. OLS analysis employed bias-corrected bootstrapped confidence intervals to account for the small sample size. The 95% confidence intervals were bootstrapped using 1000 samples using the bias-corrected and accelerated (BCa) method (Hesterberg, 2015).

TABLE 4
MULTIVARIATE REGRESSION ANALYSIS

Dependent variable (DV) by Independent Variable (IV)	*B*	*Std. β*	*SE*	*p*	95% CIs *LL*	95% CIs *UL*
DV: Hospital quality						
Intercept	41.15		11.60	0.001**	17.52	64.79
IV: Intellectual capital	5.45	0.235	3.98	0.181	-2.66	13.56
DV: Employee productivity						
Intercept	0.91		0.03	0.0001**	0.84	0.97
IV: Intellectual capital	**0.03**	**0.468**	**0.01**	**0.005****	**0.01**	**0.05**
DV: Length of stay						
Intercept	6.12		0.65	0.0001**	4.79	7.45
IV: Intellectual capital	**-0.59**	**-0.422**	**0.22**	**0.013***	**-1.05**	**-0.13**
DV: Patient satisfaction						
Intercept	53.65		27.07	0.056	-1.48	108.79
IV: Intellectual capital	0.91	0.017	9.29	0.923	-18.01	19.83

Overall model goodness of fit: $F(4, 29) = 3.50$, $p = .019$. Hospital quality: $F(1, 32) = 1.87$, $p = .181$, $R^2 = .055$, adjusted $R^2 = .026$. Employee productivity: $F(1, 32) = 9.00$, $p = .005$, $R^2 = .219$, adjusted $R^2 = .195$. Length of stay: $F(1, 32) = 6.94$, $p = .013$, $R^2 = .178$, adjusted $R^2 = .153$. Patient satisfaction: $F(1, 32) = .10$, $p = .923$, $R^2 = .000$, adjusted $R^2 = -.031$. Number of observations is 34. * and ** represent statistically significant at 5% and 1% levels.

MULTIVARIATE REGRESSION ANALYSIS

Table 4 presents the results from multivariate regression analysis using the OLS method. The overall model goodness of fit is significant, F (4, 29) = 3.50, p = 0.019 and this model accounted for 2.6% of the variance in hospital quality, 19.5% of the variance in productivity, 15.2% of the variance in length of stay, and 0.001% of the variance in patient satisfaction.

We find that intellectual capital was a simultaneously significant predictor of

employee productivity and patient length of stay and was not a significant predictor of hospital quality metrics or patient satisfaction in this model. There was a strong positive relationship between intellectual capital and employee productivity, i.e., as intellectual capital increased, employee productivity increased (*Std. β* = 0.468, p = 0.005). Conversely, there was a strong negative relationship between intellectual capital and patient length of stay, i.e., as intellectual capital increased, the patient length of stay decreased (*Std. β* = -0.422, p = 0.013).

We find no correlation between intellectual capital and hospital quality and no correlation between intellectual capital and patient satisfaction, hence we do not find evidence to support our H1 and H4. This lack of relationship between intellectual capital and hospital quality and patient satisfaction may be explained by the fact that a number of other factors impacts both quality and patient satisfaction. For example, nursing care and physician communication skills have both been shown to be critical factors in overall patient satisfaction (Arshad, Shamila, Jabeen, & Fazli, 2012; Cheng, Yang, & Chiang, 2003; Kim, Kaplowitz, & Johnston, 2004; Otani, Herrmann, & Kurz, 2011). With this in mind, increasing intellectual capital may not affect patient satisfaction scores if the quality of nursing care is sub-par or the physician does not communicate effectively. Similarly, hospital quality scores are affected by facilities-related and human-factor-related considerations (Oswald, Turner, Snipes, & Butler, 1998). Hence, employee productivity could already represent the hospital's quality.

CONCLUSION

While technological advancement has allowed hospitals to increase efficiencies and reduce the mortality rate, this study examines the importance of intellectual capital to improve efficiency and productivities in the hospital setting. Specifically, we examine the role of intellectual capital on four key performance indicators (KPIs): hospital quality, employee productivity, length of stay, and patient satisfaction.

The results indicate that greater intellectual capital was correlated with higher employee productivity and lower patient length of stay, while not with hospital quality or patient satisfaction. This result supports the theoretical supposition that intellectual capital can serve as an antecedent of hospital-improved performance. More importantly, our findings highlight the importance of intellectual capital to increase the efficiency that allows hospitals to increase the capacity to accept patients by reducing the patients' length of stay and increasing employee productivity. This is particularly crucial as the proportion of the aging population continues to increase over time and to increase readiness for hospitals to provide healthcare services during unanticipated global pandemics as we have experienced during most recent years.

We recommend that future studies should further explore different types of intellectual capital (Inkinen, 2015), such as the role of technological capital, i.e., utilization of technical knowledge and efforts put into research and development, and information capital, i.e., quality of the information system in an organization, at the hospital facility-level and individual-level. Future studies could also examine intellectual capital's role in improving access, quality and performance, especially in rural hospitals (O'Hanlon et al., 2019).

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APPENDIX 1: INDIVIDUAL SURVEY QUESTIONNAIRE FOR INTELLECTUAL CAPITAL

The following questions concern knowledge capabilities of the hospital

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Our hospital effectively learns new opportunities.	○	○	○	○	○
Our hospital successfully learns how to better satisfy our customers.	○	○	○	○	○
Our hospital successfully learns how to be more competitive.	○	○	○	○	○
Our hospital discovers new ways to be a better hospital.	○	○	○	○	○

Prev Done