

Original Research Article

The Impact of Technology Investment Decisions on Public Hospital Financial Performance

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ABSTRACT

Objectives: In this study, the impact of technology investments on hospital financial performance and the mediating variable role of cost and quality performance were researched.

Methods: To this end, a survey was carried out in 2014 over the data acquired from 383 hospitals (55%) affiliated with Public Hospital Associations under the Ministry of Health Turkish Public Hospitals Institution. In the evaluation of the data, confirmatory factor analysis, correlation analysis and structural equation modelling were utilized.

Results: As a result of the study, it was concluded that in hospitals, investments made in clinical technology, office technologies and information technologies have positively significant contributions to financial ($\beta=0.45$, $p<0.01$), cost ($\beta=0.54$, $p<0.01$) and quality performances ($\beta=0.43$, $p<0.01$) of these institutions.

Conclusion: According to the results of the survey, it was concluded that technology investments positively affect hospital financial performance and that cost and quality performance has a partial mediating role with regard to the financial performance of hospitals.

Keywords: health technology investments, hospital management, cost performance, quality performance, financial performance, structural equation modeling.

INTRODUCTION

In all societies, the service sector is at the centre of economic activities. Indeed, no economy can be functional without a substructure of service institutions which supply transportation, education and health services. Therefore, knowing how to effectively manage an organization which provides services has become a priority. The health sector is a patient-oriented service sector that requires a constant interaction with its customers. ⁽¹⁾ In health sector, a failure to meet the demand carries grave consequences than it would in other service sectors such as restaurants, travel agencies or hotels. Denying or limiting service to patients can have negative consequences

including patient mortality. ⁽²⁾ The service quality of a hospital can only be improved via activities impacting upon the process of production of services. Investing in technology, or in other words, in up-to-date equipments and information systems, is among these activities. ⁽³⁾

Technology is defined particularly as the practical application of knowledge in a certain area. ⁽⁴⁾ For the purposes of this study, technology is defined as a hospital's ability to provide medical service based on the equipment and/or the skills necessary for the service. ⁽⁵⁾ In the studies of Li and Rubin, ⁽⁶⁾ management of technology investments was addressed in three dimensions, namely; information, clinical

and office technologies. However, in a subsequent study hospital technology was evaluated in two dimensions as clinical and information technology. ⁽⁷⁾ Hospital clinical technologies are high technologies utilized in laboratories, the radiology department, surgery rooms and pharmacies. Hospital information technologies denote the establishment, keeping up and updating of the patient database. In addition, office technologies which are considered in numerous studies as part of the information technologies involve computers, announcement systems and internet-intranet investments. ⁽⁸⁾ Lately, health services technology management has focused on such technologies and the impact of advanced technology on hospital performance. Clinical and information technologies widen the content and range of service provision options and improve the capability of the employees to supply high quality services and patient care. ⁽⁷⁾ the most widely utilized performance indicators are treatment costs and medical quality. ⁽⁹⁾ It is supported in the literature that there is a direct relation between hospital technology and cost and quality. In general, it is revealed that through an active management and utilization of technology, substantial improvements as regards the cost savings and quality improvements can be achieved. ^(10,11,7) In this study, we used empirical methods to assess the impact of technology investments on cost and quality performance in Turkish public hospitals, and the link between these factors and hospital financial performance.

Background literature and hypothesis development

Cost performance with relation to technology displays variance. In researches carried out on the impact of technology on health service costs, it is presupposed that technology is expensive and, accordingly, increases the costs. However, if hospitals are to compete within this sector, they should be investing in newly developed and highly visible devices and procedures. In addition to this, some technological

developments can reduce the costs or the broadness of the utilization of such technologies can influence the costs. ⁽⁴⁾ In regulations and reforms done on health services in many countries, reducing hospital costs without lowering the quality of the services becomes apparent as the key factor. ⁽⁸⁾ Based on the literature, the hypotheses below regarding the impact of technology on hospital cost performance were developed.

Hypothesis 1: Technology investment decisions have a significant effect on hospital cost performance.

Li and Benton have also suggested that considerable cost savings and quality improvements can be achieved via investments in new technologies and the effective management thereof. Clinical technologies such as laboratory, radiology or pharmacology technologies allow the hospitals to handle large amounts of information, store patient medical information, make patient medical history available for patient care. ⁽¹⁰⁾ As a matter of fact, in our day a safe patient care has become inconceivable without computer based clinical systems. Clinical systems can immediately detect an interaction between the medications of the patient. These systems can also improve the performance of physicians and, in some cases, treatment results and prevent medical mistakes. ^(12,13,2)

Based on the literature, the hypotheses below regarding the impact of technology on hospital quality performance were developed.

Hypothesis 2: Technology investment decisions have a significant effect on hospital quality performance.

Use of technology provides hospitals with considerable advantages in providing high quality services at a reasonable cost. Many authors have investigated the relationship between technology investments and hospital financial performance. ⁽⁸⁾ Menachemi et al. ⁽¹¹⁾ and Irwin et al. ⁽¹⁴⁾ found out a significant and positive relationship between increased levels of technology use and financial

performance. Parante and Dunbar ⁽¹⁵⁾ also found that hospitals with integrated information systems had a 1.7% higher total margin and a 1.0% higher operating margin in 1993 than hospitals without integrated information systems. Bazzoli et al. ⁽¹⁶⁾ revealed that hospitals belonging to highly centralized networks had better financial performance than those belonging to more decentralized networks. Finally, Kwangsoo and Wan ⁽¹⁷⁾ investigated the relationship between technology adoption, efficiency and hospital performance using data from 349 urban hospitals, measured in 1997 and 1998. Their results showed that deploying a highly integrated technology adoption strategy was negatively associated with the 1997 efficiency score and changed towards a positive direction in 1998. Based on the literature, the hypotheses below regarding the impact of technology on hospital financial performance were developed.

Hypothesis 3: Technology investment decisions have a direct effect on hospital financial performance.

Hypothesis 4: Hospital cost performance mediates the relationship between technology investment and financial performance.

Hypothesis 5: Hospital quality performance mediates the relationship between technology investment and financial performance.

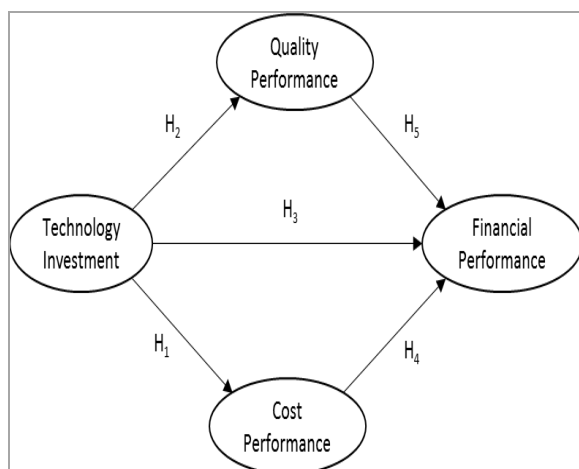


Figure 1: Hypothesized Model

The conceptual research model is shown in Fig. 1. As defined in Figure 1, the

input (exogenous) construct is the hospital technology investment, the intermediate constructs are two different types of performance (quality and cost), and the output construct is hospital financial performance.

MATERIALS AND METHODS

Sample and Data Collections

Public Hospital Associations (PHA) were established in each province (with more than one PHAs in major provinces) in order to improve the quality and financial performance of publicly owned hospitals in Turkey. The management of secondary and tertiary health care institutions located within a province was assigned to the office of the secretary general of these unions. In 2014, the number of PHAs under the Ministry of Health Turkish Public Hospitals Institution was 88, comprising of a total of 697 hospitals. Within this framework, the measures utilized in the survey were distributed to the 88 PHAs and 383 hospitals (55%) affiliated with 42 unions accepted to contribute to the research.

Measures

All items are measured on a scale ranging from 1 (strongly disagree or very few) to 5 (strongly agree or too much).

Technology Investments: Respondents completed the 13-item technology investments scale developed by Li and Collier ⁽⁷⁾ and Li and Rubin ⁽⁶⁾ to measure the respondents' perceptions about the amount of technology investments undertaken in their hospitals. The suitability for use in Turkish, the validity and the reliability of this measure was ensured by Çetin. ⁽¹⁸⁾ The three dimensions measured; Information technologies (four items $\alpha=0.86$), office technologies (three items, $\alpha=0.86$) and clinical technologies (six items, $\alpha=0.71$).

Cost Performance: Respondents completed the 10-item cost performance scale developed by Li et al. ⁽¹⁾ Li and Rubin, ⁽⁶⁾ Li and Benton, ⁽¹⁰⁾ to measure the respondents' perceptions about the amount of cost performance in their hospitals. The

suitability for use in Turkish, the validity and the reliability of this measure was ensured by Çetin. ⁽¹⁸⁾ (ten items, $\alpha=0.83$).

Quality Performance: Respondents completed the 16-item quality performance scale developed by Li et al. ⁽¹⁾ Li and Rubin, ⁽⁶⁾ Li and Benton ⁽¹⁰⁾ to measure the respondents' perceptions about the amount of quality performance in their hospitals. The suitability for use in Turkish, the validity and the reliability of this measure was ensured by Çetin. ⁽¹⁸⁾ (sixteen items, $\alpha=0.92$).

Financial Performance: Respondents completed the 8-item financial performance scale developed by Li and Collier, ⁽⁷⁾ Li et al. ⁽⁴⁾ Bazzoli et al. ⁽¹⁶⁾ to measure the respondents' perceptions about the amount of financial performance in their hospitals. The suitability for use in Turkish, the validity and the reliability of this measure was ensured by Çetin. ⁽¹⁸⁾ (eight items, $\alpha=0.92$).

The fit for the hypothesized model is evaluated by using traditional goodness of fit measures: goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normed fit index (NFI), comparative fit index (CFI), and root square mean of approximation (RMSEA).

Data aggregation

Firstly, the data were tailored for analysis. We used confirmatory factor analysis (CFA) with SPSS 23 to determine each scale items factor loadings. Three significant dimensions are obtained as a result of our analysis: information technology ($\alpha=0.837$), office technology ($\alpha=0.693$) and clinical technology ($\alpha=0.817$), which we use as our main effect independent variables ($p=0$, $df=55$, $KMO=0.765$). Then we analyze cost performance, quality performance and financial performance, which are the dependent variables. Three item from cost performance ($p=0$, $df=21$, $KMO=0.815$) and 7 item from quality performance ($p=0$, $df=36$, $KMO=0.894$) should be dropped because of low factor loadings.

RESULTS

Descriptive statistics

The means, standard deviations, intercorrelations and scale reliabilities among the key variables are presented in Table 1. According to the table, it is seen that there is a positively significant relation between ethical leadership, ethical climate and organizational identification.

Table 1: Descriptive statistics, reliabilities, and correlations among variables

Variables	Mean	SD	1	2	3	4
Technology Investments	2,863	0.652	(0.885)**			
Cost Performance	3.093	0.619	0.431*	(0.847)**		
Quality Performance	3,561	0.604	0.339*	0.401*	(0.927)**	
Financial Performance	3,005	0.724	0.357*	0.738*	0.434*	(0.929)**

*Correlation is significant at the 0.01 level (2-tailed), **Cronbach's alpha; SD = Standard deviation, Note. n=383.

Measurement model

First of all, we tested our variables for model fit. We used confirmatory factor analysis (CFA) with SPSS Amos 23 to test our variables. We tested a measurement model that had four latent factors (i.e., technology investments, cost performance, quality performance and financial performance) and 20 indicators (3 dimensions for technology investments, seven items for cost performance, nine items for quality performance, and one dimension for financial performance). The modification indices indicate that three

variables should be dropped because of low factor loadings. One item from the cost performance and 2 items from the quality performance scales were dropped. We use generally, the measurement model as analyzed using a CFA of the variables indicates a good fit ($\chi^2=149.57$, $df=109$, $p<0.01$, $GFI=0.84$, $AGFI=0.82$, $NFI=0.95$, $CFI=0.95$, $RMSEA=0.07$). ^(19,20)

Structural model

The next step in analyzing the data is to test the hypothesized model. We used structural equation modeling (path analysis) with Amos 23 to test our hypothesis. Having

confirmed that the measurement model had adequate fit, we tested our proposed structural model. Results of the structural analysis of the proposed model provides an acceptable fit to the data ($\chi^2 = 153.12$, $df = 111$, $p < 0.01$; $GFI=0.84$, $AGFI=0.81$, $NFI=0.91$, $CFI=0.95$, $RMSEA=0.07$), (fig.2).

The first hypothesis examines the relationship between technology investment and cost performance. In support of

Hypothesis 1, the path coefficient between technology investment and cost performance ($\beta = 0.54$, $p < 0.01$) was positive and significant. Technology investment influences health institution's cost performance. Hypothesis 2 analyses the relationship between technology investment and quality performance. The results indicate that technology investment is related positively to health institution's quality performance ($\beta = 0.43$, $p < 0.01$).

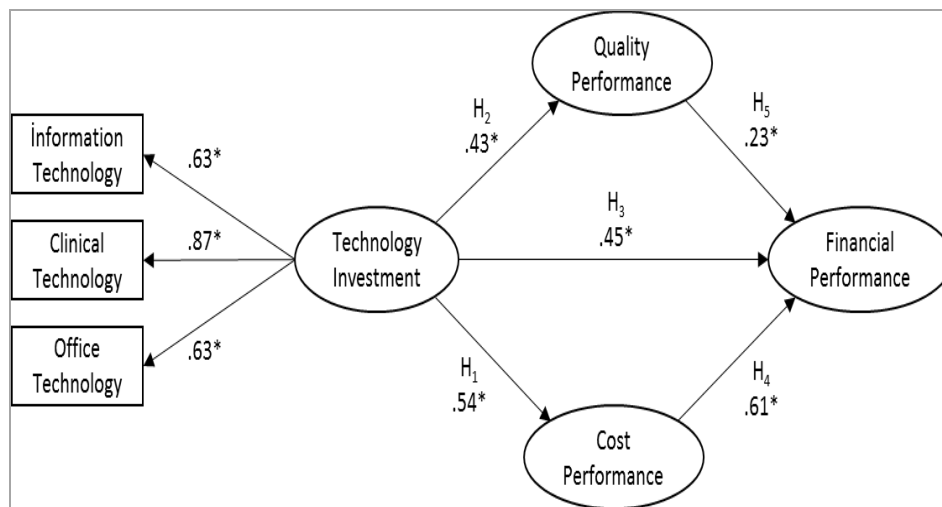


Figure 2: Final Model * $P < 0.001$

Hypothesis 3 predicted that technology investment is positively related to financial performance. We also found support for this hypothesis ($\beta = 0.45$, $p < 0.01$). Our hypothesis structural model (fig. 2) builds on partially mediated model (fig.1). If as a result of the goodness of fit test there is a direct path and also an indirect path between the independent variable and the output, this is called the partial mediation model. Hypothesis 4 predicted that cost performance mediates the relationship between technology investment and financial performance. The results indicate that technology investment influences financial performance through cost performance ($\beta = 0.61$, $p < 0.01$). Hypothesis 5 also predicted that quality performance mediates the relationship between technology investment and financial performance. The results indicate that technology investment influences financial performance through quality

performance ($\beta = 0.23$, $p < 0.01$). To test the goodness-of fit of cost performance and the quality performance as the mediators between technology investment and financial performance we calculated the product of coefficients (of the independent variable and mediators) with bootstrap analysis by using Amos 23. The indirect effect was significant for the relationship between technology investment and financial performance ($\beta = 0.43$, $p < 0.01$).

DISCUSSION

There are many reasons as to why hospitals invest in technology, including profit maximization and medical and technological superiority. (5) There are many visible and invisible organizational and clinical benefits of health technology, and generally, the introduction of new technologies to the hospital causes changes in the organizational structure, business processes and skill requirements of the

employees. ⁽¹⁰⁾ This survey was conducted over 383 hospitals under 42 PHAs in Turkey. As a result of the study, it was concluded that in hospitals, investments made in clinical technology, office technologies and information technologies have positively significant contributions to financial, cost and quality performances of these institutions. In addition, it was observed that technology investment improved quality performances and, with this positive influence, financial performance was also indirectly improved. In other words, it was concluded that cost and quality performances had a significant partial mediation role in the positive relation between technology investments and financial performance.

A similar study was carried out by Tansel Cetin et al. ⁽⁸⁾ who researched the impact of technology investments on cost and quality performance and the mediating effects of hospital size and region in Turkish hospitals. It was concluded that information/office and clinical technologies have a statistically significant effect on a hospital's cost and quality performance. In the study carried out by Li et al., the effects of the management of hospital technology investments on quality performance were found to be statistically significant. ^(6,10) Moreover, it is observed from another study conducted by Li and Collier ⁽⁷⁾ that technology has statistically significant impacts upon financial performance. In this study it was similarly concluded that technology had a statistically significant effect on financial performance through cost and quality performance and that the findings supported the literature.

CONCLUSION

Even though technology investments in hospitals cause an increase in costs at the outset; since in the long run they alleviate procedures regarding service provision, establish a true diagnosis in short time, save time, prevent medical mistakes and improve labour productivity they will contribute

greatly in terms of both reducing the costs and improving the quality of services.

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