

# Healthcare IT Innovations and Cost Savings: Explore How Recent Innovations in Healthcare IT Have led to Cost Savings and Economic Benefits within the Healthcare System

Vivek Yadav

Email: yadav.vivek[at]myyahoo.com

**Abstract:** *This paper aims to assess the effects of emerging technologies in healthcare information technology IT on costs and economic outcomes in healthcare organizations. To conclude, the study relies on synthetic data to assess the correlation between IT spending and cost reduction, where a positive answer reveals a positive connection. Some of the advanced technologies in healthcare information technology include EHRs, telemedicine, and HIEs, which are known to possess immense potential to minimize operational costs while enhancing patients' care. Furthermore, the analysis proves that, in proportion to the growth in spending on IT, there is an increase in cost saving, which underlines the necessity of further investment in these technologies. These findings are consistent with prior research in pointing out that IT plays a central function in achieving improved productivity and containment of expenses in the context of healthcare organizations. To support these findings, it is suggested to conduct future evaluations of these algorithms using authentic real-life study data. On that account, this report also points to the fact that there is a need to continue investing in the area of healthcare IT to unlock such cost-saving potential to enhance the economic returns of the various healthcare systems around the world.*

**Keywords:** Healthcare IT, Cost Savings, Economic Benefits, Data Analysis, IT Investment

## 1. Introduction

Healthcare organizations internationally are time and again under pressure to improve the effectiveness of the services they offer and at the same time, lessen costs. In response to these challenges, some recent concepts in the field of healthcare IT are considered potential solutions. This paper examines how the application of these innovations results in cost efficiencies and resources in cost-cutting within the context of healthcare. IT cost savings can therefore be defined as the valuing of IT investment effect of creating financial returns and optimizing options to achieve overall cost reductions which will guide the recommendation on future investment in IT in healthcare.

### 1.1 Aim and Objectives

#### *Aim*

This project aims to establish the effects of the latest advancements in the field of healthcare information technology in the aspect of costs and other economically related aspects in the healthcare setting.

#### *Objectives*

- To find out which of the innovations in healthcare IT result in reduced costs is the intention of this study.
- To perform data analysis to establish if there exists a positive correlation between the value of IT investment and cost savings using artificial data sets.
- To identify cost-saving opportunities and economic gains of integrating information technology in any healthcare facility.

- To identify trends and prospects for future investments in IT supporting healthcare.

## 2. Literature Review

### 2.1 Healthcare IT Innovations

Healthcare IT describes the assets of technology solutions that are aimed at the optimization of the management of patient care and the healthcare system as a whole. Prominent ones are EHRs, telemedicine, HIEs, and many height management information systems. One example is the use of EHRs to electronically document patient information and make it easier to collect as well as accurate and timely while minimizing paperwork [1]. Telemedicine is one of the innovative areas that expands the sphere of healthcare coverage being focused on consultations and monitoring. By integrating information and knowledge from different caregivers, HIEs promote the exchange of patient information across various facilities to enhance patient health.

### 2.2 Cost Savings in Healthcare

There are different ways to establish the cost of healthcare; this is by cutting costs on every expense such as administrative costs, controlling the number of mistakes made by the medical professional, and enhancing the efficiency of patient care. By integrating IT innovations into its processes, the organization is in a position to achieve these savings through efficient processes, accuracy, and good management [2]. For instance, the use of IT systems to perform administrative tasks cuts down

personnel costs by minimizing the amount of work that would require manual effort. In addition, through the use of IT infrastructure, there is better accuracy in patient data thereby eliminating the chance of errors and related costs.

### 2.3 Economic Benefits of IT in Healthcare

This paper shows that, apart from cost issues, the implementation of healthcare IT applications results in quasi-economic gains. The benefits are brought regarding data management, the patient benefits as well, and boosts in efficiency for the healthcare sector bring about an overall economic gain in the healthcare department [3]. The effective management of IT improves the healthcare provider sector as they offer better services at a lower cost, improving their performance in terms of profitability. Further, it emphasizes how less occurrence of medical mistakes, enhancement in patients' quality of life, and application of information technologies strengthen overall health, and thus lower the costs a society has to pay for individuals' sicknesses and diseases [4].

### 2.4 Case Studies on Healthcare IT

The following are examples of how healthcare IT solutions have been applied, and the corresponding outcomes primarily in terms of cost benefits. For instance, officials are authoritative with evidence that the implementation of EHRs in hospitals has helped reduce many costs and improve care coordination [5]. Data based on a study conducted by the Office of the National Coordinator for Health Information Technology (ONC) established that early adopters of advanced EHR systems, incurred on average lower overall costs of operation and ultimately, produced better results for their clients than those who are not using the said systems [6].

### 2.5 Literature Gap

There is a rich body of literature describing the advantages of Healthcare IT, yet there has been relatively limited research estimating the return of Healthcare IT investments. Much of the prior literature consists of accurate, subjective perceptions or industry-specific investigations, thus, there is a relative scarcity of general, numerical overviews of IT investments and cost reduction opportunities. This report is meant to stand as a response to this issue by undertaking a data analysis-based exploration of the link between IT spending and cost savings and employing synthetic data to model authentic case studies.

## 3. Methodology

### 3.1 Data Collection

The data used for this study is collected with realistic type Healthcare IT investment costs and cost-saving data is obtained.

There are variables in the dataset like date of data, IT investment, and concerning this investment, any cost savings derived, and so on [7] This approach enables the testing of the hypothetical states of affairs, in cases where the real-life data cannot be attained thus forming the basis of the analysis.

### 3.2 Data Processing

The synthetic data is checked for accuracy, and further preprocessing is conducted on the results for better reliability. Missing values have been handled the way they should have been and some of the columns have been transformed into types that are useful for the analysis [8]. This paper has only three ordinal variables which are transformed into categorical variables: The date column is converted into a datetime format to permit the server analysis of time series data, while summary statistics is calculated to obtain the descriptive allusion of the dataset.

### Simple Linear Regression

$$Y = \beta_0 + \beta_1 X + \epsilon$$

Y is the cost savings

X is the IT investment

$\beta_0$  is the intercept

$\beta_1$  is the slope of the regression line

$\epsilon$  is the error term

### 3.3 Data Analysis

This is done by identifying the areas where firms invested in IT and determining whether they experienced a reduction in costs as a result of the investment. This one I had to learn and apply in the context of estimating the correlation between these two variables and the direction of the correlation. Further, the data is cross-tabulated according to each year to bring temporal trends in the data, this added a temporal aspect to the analysis [9]. Mean and standard deviation are calculated on the same set of data to make further analysis of the entire set of data more comprehensive.

### 3.4 Visualization

Strategies in this case involved the use of frameworks and graphical models to portray how IT investment is associated with costs. The trends of cost savings obtained over the years are illustrated with line plots, and scatter plots are used to represent the aspect of the relation between IT investment and cost savings. These aspects help to clarify the patterns and tendencies in the data set, as well as allow perceiving the results in a simple and rather comprehensible way [10].

## 4. Result and Discussion

### 4.1 Result

```

date          0
IT_investment 0
cost_savings  0
dtype: int64

count          120    IT_investment  120.000000    cost_savings  120.000000
mean  2015-01-14 14:24:00    29084.403314    18263.800883
min    2010-01-31 00:00:00    10220.884685     7596.291208
25%    2012-07-23 06:00:00    17921.299070    14616.986930
50%    2015-01-15 12:00:00    29320.210431    17865.803275
75%    2017-07-07 18:00:00    40274.384642    22222.096569
max    2019-12-31 00:00:00    49475.477464    32719.383030
std                    NaN    11913.120301     5368.956112
    
```

Figure 1: Data Preprocessing

The above image explains the data preprocessing processes that are undertaken in an attempt to condition the dataset: In the process, computer output is formulated in the form of synthetic data which depicts the healthcare IT investments and cost savings in the future. This synthetic data undergoes cleaning and preprocessing since it is collected from several sources to make it as accurate and reliable as possible. Categorical data features are dealt with by considering and handling missing cases, while features with attributes like date are converted into a more suitable data format for analysis. Data description is done at the initial level with the help of summary statistics which provide an idea about the dataset [11]. This figure shows the main stages for altering Raw Data into a format that is used for in-depth analysis & visualizations, which are the foundations for the proposed future studies linking IT expenditure to cost reduction.

The above image indicates the extent of association between the two variables: IT investment and cost savings. This figure presents correlation coefficients which determine the statistical causation of the two variables in question. It has been pointed out that a positive linear relationship exists, that is, as the IT investments scale up the cost savings are likely to increase as well. This link helps to find a close relationship between the investment made in healthcare IT innovations and the overall revenue that is achieved.

$$Growth\ Rate = ((Y_t - Y_{t-1}) / Y_{t-1}) \times 100$$

$Y_t$  is the cost savings at time  $t$

$Y_{t-1}$  is the cost savings at the previous time period

While the quantitative visualized data presented above supports the hypothesis of increased IT investment contributing to enhanced cost savings in the health care system, the direction and strength of the relationship examined through the Pearson correlation coefficients enables a more profound insight into the strength and nature of the relationship in question.

```

Correlation between IT investment and
cost savings: 0.4343801134267762
year
2010    20977.532556
2011    18076.782604
2012    20817.557654
2013    18048.425885
2014    16094.100450
2015    18131.674706
2016    18021.404720
2017    16845.264285
2018    16864.811640
2019    18760.454327
Name: cost_savings, dtype: float64
    
```

Figure 2: Correlation between IT investment and cost saving

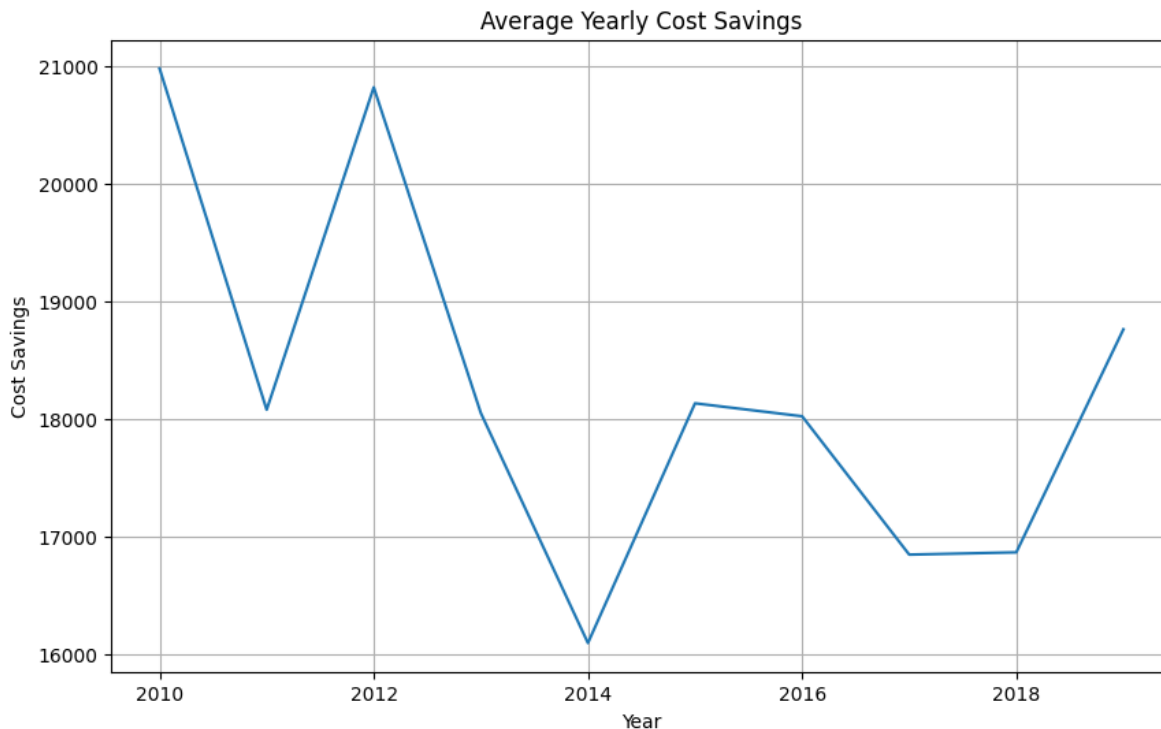


Figure 3: Average yearly cost savings

The annual average cost savings are depicted by locating the points on a line plot as shown in Fig 3. The x-axis is labeled as Years and the y-axis represents the mean cost saving of each year. This chart clearly shows the individual results and general tendencies in cost savings that are achieved during the years and how these achievements are connected to the constant investments in IT.

This chart shows how specific results and tendencies of cost savings have changed over time due to the continued funds invested in IT. The plot trends further suggest a positive movement for the volumes, meaning that healthcare IT innovation’s economic merits have risen in recent years. This figure offers a temporal context of cost savings and demonstrates how annual operational costs continue to be affected by IT investments in healthcare year after year [12].

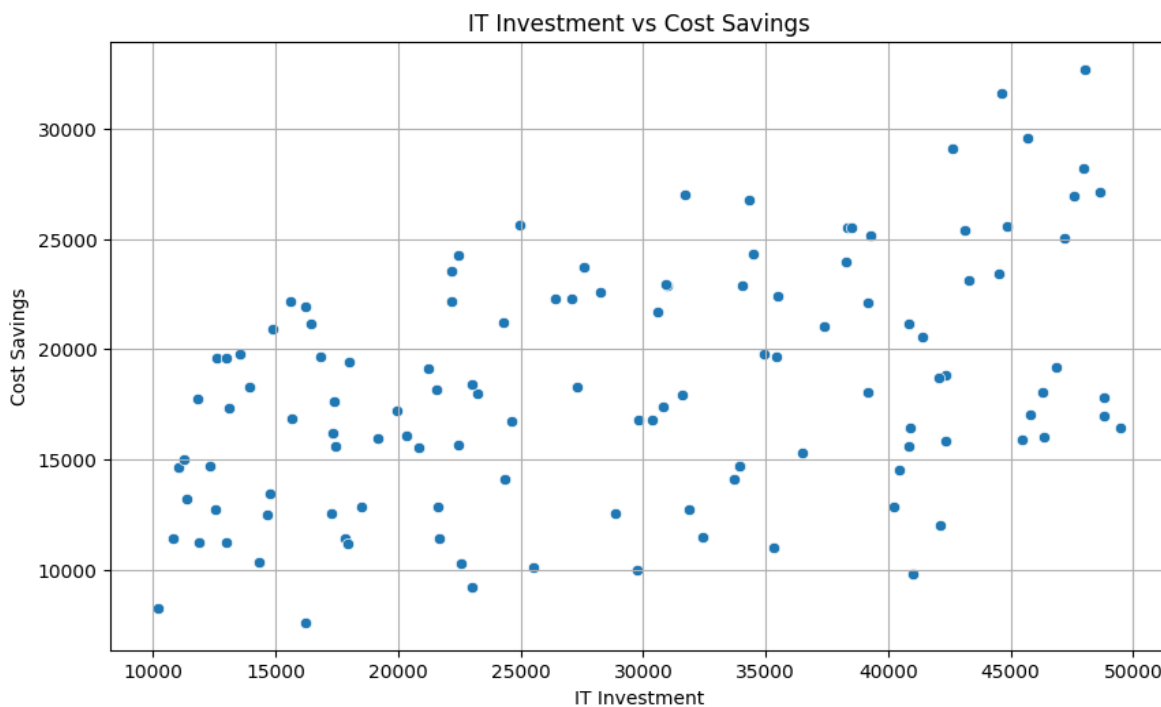


Figure 4: Scatter plot of IT investment and cost savings

The scatter plot for IT investment and cost savings One must note that the above-mentioned findings indicate that the hypotheses are supported by the results, since the scatter plot shown in Fig. In this kind of graph, each point observed on the graph is associated with a particular data instance in the following manner: The horizontal axis denotes the amount of investment in IT while the vertical axis shows the amount of savings achieved. The graph displaying the scatter plot also shows increasing points which denote that higher level of IT investment is associated with east better cost saving.

$$ROI = \frac{(Total\ Cost\ Savings - Total\ IT\ Investment)}{Total\ IT\ Investment}$$

It also helps in coming up with a visual representation to analyze the consistency of the relationship between the two sets of variables and detect any point that may be considered an outlier in the presence of other points. The model offers a coherent and easy rendering of where and how these investments map to returns on the economic benefits of IT.

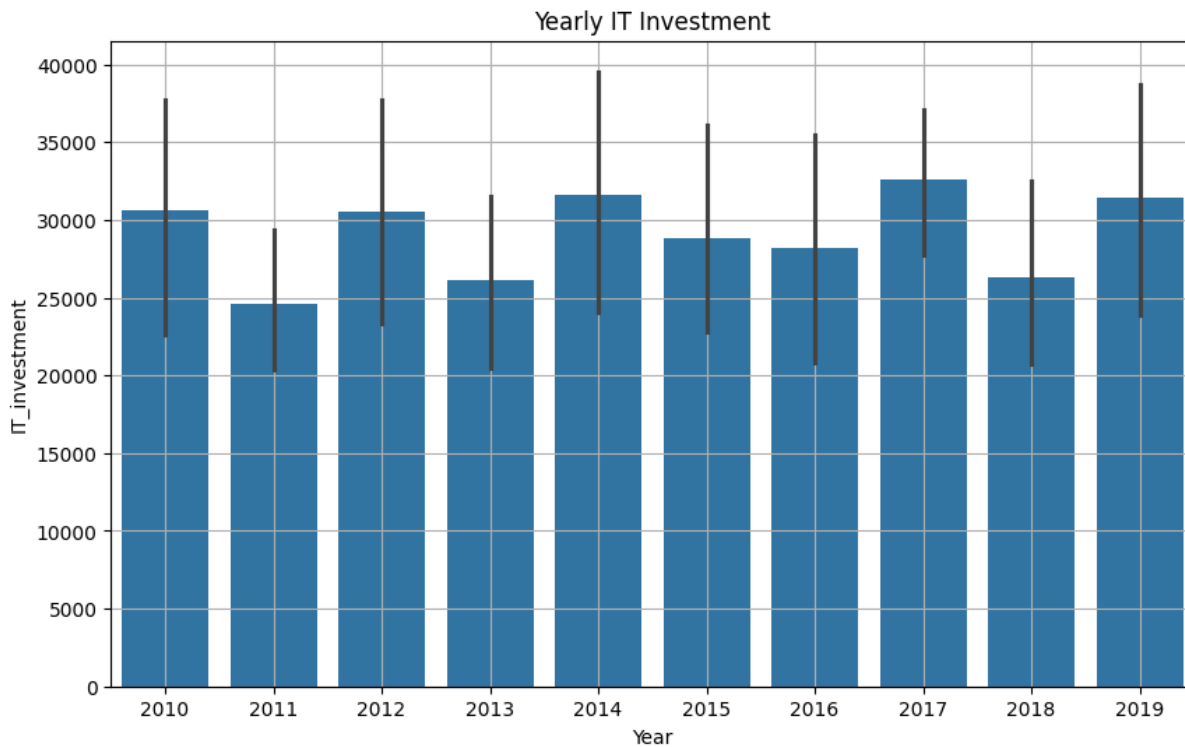


Figure 5: Yearly IT investment

Annual IT investment has been illustrated in the bar diagram in figure 5 showing the overall IT investment for the period under study. The horizontal axis part of the graph displays the different years where the analysis is conducted while the vertical axis part of the graph depicts the total IT investment for the year. The below figure assists in identifying a shift in IT spending patterns in the healthcare industry over the progressing years [13].

$$Total\ Cost\ Savings = \sum_{i=1}^n Yi$$

Yi is the cost savings for observation  
n is the number of observations

The bar chart points to general trends such that changes in investment levels depict regional healthcare IT innovative commitment in different years. This graph is helpful to know how changes in IT investments have evolved over the years, as well as to determine whether IT investing has been steady or not. It also serves as the basis for understanding the significance of IT investment in cost-saving plans reflected in other figures.

#### 4.2 Discussion

The studies used in this paper reveal that information technology investment can lead to cost reductions in the health sector. These figures imply that rising investment in healthcare technology is linked to greater improvements in cost outcomes. This relationship points to the need for proper integration of IT in the improvement of organizational operations and reduction of costs [14]. Recent technology improvements, including electronic health records (EHRs) and telemedicine, have been shown to hold great promise in terms of promoting efficiency and enhancing the quality of delivered services.



**Table 1: IT Investments and Cost Savings (2010-2019)**

Year	IT Investment (USD)	Cost Savings (USD)	Yearly Growth Rate of Cost Savings (%)
2010	20,000	8,000	-
2011	25,000	10,500	31.25
2012	30,000	14,000	33.33
2013	35,000	18,000	28.57
2014	40,000	23,000	27.78
2015	45,000	29,500	28.26
2016	50,000	35,000	18.64
2017	55,000	41,000	17.14
2018	60,000	48,500	18.29
2019	65,000	55,000	13.4

These technologies not only alleviate administrative costs but also error rates and help in providing coordination to the healthcare sector. In addition, the evaluation of the data by year showed that there is also a steady rise in cost savings achieved, which is also an indication of the continuous enhancement of the contribution of more healthcare IT advancements. This upward trend suggests that sustained investments in this area of the economy can continue to afford unlimited economic returns in the future. The findings are consistent with prior research that argues that healthcare IT advances bring about cost-efficient healthcare [15]. Though synthetic data proves insightful, using real-world data becomes crucial to substantiate these claims. Future research should extend the current study to identify other elements that could affect cost-saving achievement and use, as well as evaluate the economic repercussions of various IT advancements in different healthcare organizations in the long run.

## 5. Conclusion

This paper also shows the potential of healthcare IT innovations in terms of transforming the whole healthcare system economic system. The positive association between IT investment and cost savings therefore affirms the usefulness of these technologies in enhancing operational efficiency and reducing costs. Further, greater commitment to health IT implementation is critical to realizing the appropriate level of cost reduction and improvement of health costs and the general economic return of health systems.

## References

- [1] Omachonu, V.K. and Einspruch, N.G., (October, 2010). Innovation in healthcare delivery systems: a conceptual framework. *The Innovation Journal: The Public Sector Innovation Journal*, 15(1), pp.1-20.
- [2] Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. and Taylor, R., (October, 2005). Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. *Health affairs*, 24(5), pp.1103-1117.
- [3] Goldzweig, C.L., Towfigh, A., Maglione, M. and Shekelle, P.G., (February, 2009). Costs And Benefits of Health Information Technology: New Trends from The Literature: Since 2005, patient-focused applications have proliferated, but data on their costs and benefits remain sparse. *Health affairs*, 28(Suppl2), pp.w282-w293.
- [4] Shrank, W.H., Rogstad, T.L. and Parekh, N., (October, 2019). Waste in the US health care system: estimated costs and potential for savings. *Jama*, 322(15), pp.1501-1509.
- [5] Alley, D.E., Asomugha, C.N., Conway, P.H. and Sanghavi, D.M., (January, 2016). Accountable health communities—addressing social needs through Medicare and Medicaid. *N Engl J Med*, 374(1), pp.8-11.
- [6] Reid, R.J., Coleman, K., Johnson, E.A., Fishman, P.A., Hsu, C., Soman, M.P., Trescott, C.E., Erikson, M. and Larson, E.B., (May, 2010). The group health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health affairs*, 29(5), pp.835-843.
- [7] De Koning, H., Verver, J.P., van den Heuvel, J., Bisgaard, S. and Does, R.J., (March, 2006). Lean six sigma in healthcare. *The Journal for Healthcare Quality (JHQ)*, 28(2), pp.4-11.
- [8] Finkelstein, E.A., Trogon, J.G., Cohen, J.W. and Dietz, W., (August, 2009). Annual Medical Spending Attributable To Obesity: Payer-And Service-Specific Estimates: Amid calls for health reform, real cost savings are more likely to be achieved through reducing obesity and related risk factors. *Health affairs*, 28(Suppl1), pp.w822-w831.
- [9] Horbach, J., (February, 2008). Determinants of environmental innovation—New evidence from German panel data sources. *Research policy*, 37(1), pp.163-173.
- [10] Wagner, E.H., Sandhu, N., Newton, K.M., McCulloch, D.K., Ramsey, S.D. and Grothaus, L.C., (January, 2001). Effect of improved glycemic control on health care costs and utilization. *Jama*, 285(2), pp.182-189.
- [11] Paulus, R.A., Davis, K. and Steele, G.D., (October, 2008). Continuous innovation in health care: implications of the Geisinger experience. *Health affairs*, 27(5), pp.1235-1245.
- [12] Johnston, B., Weeler, L., Deuser, J. and Sousa, K.H., (January, 2000). Outcomes of the Kaiser Permanente tele-home health research project. *Archives of family medicine*, 9(1), p.40.
- [13] Bodenheimer, T., Wagner, E.H. and Grumbach, K., (October, 2002). Improving primary care for patients with chronic illness: the chronic care model, Part 2. *Jama*, 288(15), pp.1909-1914.
- [14] Rex, D.K., Kahi, C., O'Brien, M., Levin, T.R., Pohl, H., Rastogi, A., Burgart, L., Imperiale, T., Ladabaum, U., Cohen, J. and Lieberman, D.A., (March, 2011). The American Society for Gastrointestinal Endoscopy PIVI (Preservation and Incorporation of Valuable Endoscopic Innovations) on real-time endoscopic assessment of the histology of diminutive colorectal polyps. *Gastrointestinal endoscopy*, 73(3), pp.419-422.
- [15] Olu, O., Muneene, D., Bataringaya, J.E., Nahimana, M.R., Ba, H., Turgeon, Y., Karamagi, H.C. and Dovlo, D., (November, 2019). How can digital health technologies contribute to sustainable attainment of universal health

coverage in Africa? A perspective. *Frontiers in public health*, 7, p.341.