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Technical Efficiency of Tanzania Teaching Hospitals: The Case of Private not for-profit Hospitals

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Abstract

In this study, we examined the technical efficiency of private teaching hospitals in Tanzania. We employed a widely used non-parametric approach (Data Envelopment Analysis) in a sample of 18 teaching hospitals. The study period covered 2009 – 2013. The result from this study is expected to be useful to the owners and administrators of teaching hospitals, giving them justification for effective planning and implementation of the strategies that will avoid abuse of the available scarce health resources. Government and policy makers may also reap some inputs (from result of this study) for health policies, particularly pertaining to research and the training of future medical experts.

Findings revealed that out of 18 teaching hospitals, only 4 (22.3%) are operating close to technical efficiency with average level of technical efficiency ranging between 92% and 98%. The remaining 14 hospitals are operating far from efficiency frontier. Overall mean scale efficiency were found to be 82.4%. With support of DEA this study has revealed inefficiency in the use of scarce health care resources in teaching hospitals in Tanzania. This requires the hospitals administrators and managers to consider steps to be taken to improve inefficiency.

Keywords: teaching hospitals, private not for profit, efficiency, data envelopment analysis, Tanzania

1. Introduction and Background

Teaching hospitals are hospitals that disseminate clinical knowledge and conducts training to future and current physicians, nurses and other health professionals in additional to delivery of healthcare services to patients. They are generally affiliated with medical schools, medical universities other terms used include clinical schools or university hospitals. Teaching hospitals are very complex and combine clinical care teaching and research, therefore they are required to meet challenges accruing from the advancement in hospitals financing and production process and which relates to efficiency performance (Mauro et al., 2012).

The growing healthcare expenditures largely influence the cost crisis and create numerous challenges on resource allocation and budgeting (Lobo et al., 2010; Gourdazi et al., 2014). They provide (teaching hospitals) clinical education for medical students, residents. According to AAMC (2012), teaching hospitals are very important because; *first* they engage in discovering tomorrow's cure and transform care, since they conduct researches on improving treatments (i.e. treatment procedures, drugs etc.); *Second*, they provide community care by giving the community teaching programs, that enabled the community to prevent, fight against diseases; *third* ,educate the future experts or physicians that is knowledge dissemination and preparing the future medical experts. In healthcare system, assessing the efficiency of hospitals is one of crucial step in gauging the individual performance of the production units or hospital or healthcare center, such undertaking provides the rational framework for the distribution and allocation human and other healthcare resources between different hospitals or departments within one hospital (Kontodimopoulos et al., 2006; Moshiri et al., 2011).

Using different techniques, teaching hospitals in different countries have been examined with different purposes. In some studies the reason was to test the impact of teaching on cost and quality of services. For example Taylor et al. (1999) examined the effect of admission to teaching hospitals to the cost, quality of care in US, in that particular study the survival of the patients admitted in teaching hospitals was high compared to non-teaching hospitals. Saleem et al. (2013) examine the autonomy and performance in teaching hospitals in Punjab, Pakistan. In a study conducted by Rosko (2004) Stochastic Frontier Analysis (SFA) was used to determine cost efficiency of teaching hospitals in USA during 1990 - 1999.

Hospital's efficiency regardless of hospitals' characteristics has been the subject of numerous health economics discipline. Hospitals efficiency scores have been determined using the data derived from the hospitals inputs and outputs used in the hospitals production process. Major hospitals' characteristics are classified according to: *Rural Vs urban hospitals; System affiliated Vs Non-system affiliated; Private Vs Public hospitals; for profit Vs Not for profit hospitals; Teaching Vs Non-teaching hospitals.* From the ongoing shortage of healthcare resources it is important for hospital managers or administrators (regardless of hospitals' characteristics) to establish the hospitals' efficiency performance in order to ensure efficiency utilization of healthcare resources. In line with this argument, the private teaching hospitals category in Tanzania is no exception of being under scrutiny to determine their efficiency

performance. University hospitals play an important role in providing healthcare with high complexity, since they engage in teaching research functions, collection of abundant health resources (both financial and physical resources) (Medicin ,2001). An important development of university hospitals is the recognition of the existence of multiple dimension in each hospitals, such as healthcare provision, teaching and research these features normally influence each other (Medicin, 2001). Number of residents, categories of products of teaching and specialization in the healthcare services is considered as the resources for the healthcare dimension influencing hospitals cost and efficiency (Lobo et al., 2010), particularly in teaching hospitals category. Residents normally represents a new physician's first assignment following the medical programs and basically last from three to five years depending on the area of specialization (Huckman et al., 2014). Ichoku et al. (2011) reported that in sub Saharan Africa average ratio is 15 doctors and 72 nurses per 100,000 people. However, the presence of the residents or medical students may lessen the impact of shortage of staff or may have impact on the cost of running the medical programs depending on the intensity of teaching programs.

1.1 Background of Studies on Hospital Efficiency

The first study examining hospitals' efficiency took places in USA in 1980s conducted by Nunmaker (1983) and Sherman (1984) DEA was employed as main technique of analysis. Since then, examining hospitals' efficiency and its determinants has been the in spotlight of the healthcare economist around the world. To mention few in US, hospitals study was also conducted by Zuckerman et al., (1994), Rosko (2001), Rosko and Chillingerian (1999), Vitaliano and Toren (1996) DEA was largely used in the analysis. The non- parametric DEA has also been used by different researchers in different parts of the world. For example in Europe, the hospitals' studies have been conducted by Prior (1996), Wang staff and Lopez (1996) who analyzed the efficiency of Spanish hospitals. In Australia Worthington (2004) and Hollingsworth (2008) provided the review of studies on hospitals' efficiency where DEA was the main tool of analysis. In Asia, DEA was used to examined hospital's efficiency by Pharm (2010) measuring the efficiency of hospitals in Vietnam. In Africa DEA was also used to examine hospitals efficiency, among few hospitals studies conducted include; Kirigia et al. (2008) measured the efficiency of hospitals in Angola; Osei et al. (2005) examined efficiency of district hospitals in Ghana; Zere et al. (2001) assessed the efficiency of hospitals in South Africa; Bwana (2015) measured technical efficiency of faith based hospitals in Tanzania; Yawe (2010) examined the efficiency of district hospitals in Uganda.

2. Objective and Significance of the Study

International literatures underline the importance of teaching hospitals within different health systems (Blue menthol et al., 1997). It is also argued that there is a need for urgent solution to the inefficiency problem in the teaching hospitals (Mechanic et al., 1998). The purpose of the study has been built on Grosskopf et al. (2004) where relative technical and scale efficiency of US teaching hospitals were examined using DEA. Therefore, the general objective is efficiency of private teaching hospitals in Tanzania. Specifically, this paper aims at measuring

relative technical and scale efficiency of private not for profit teaching hospitals in Tanzania.

2.1 Significance of the Study and Structure of the Paper

Hospitals consume larger part of the limited healthcare resources (budgets), therefore efficient use of the resources is one of the main concern in the industry in developing countries (McKee and Healy, 2002) with no exception to Tanzania. The result from this study will help managers, administrators of teaching hospitals to improve the efficiency of the private teaching hospitals in Tanzania. Most of these private teaching hospitals are faith based and some of them have been in partnership with the government, it is obvious that the result will also be useful to the government and policy makers particularly when planning for the future demand of the medical experts (i.e. physicians). The result of the study will also help the government which usually provides resources to these hospitals, to make follow up on the use of the resources hence avoid the abuse of scarce health resources provided by state or donors to the teaching hospitals. The study is also expected to contribute to the existing body of knowledge of hospitals efficiency as well as literature particularly teaching hospitals literature, hence broaden the platform for the hospitals comparison based on the hospitals characteristics in Tanzania. The remainder of this paper is structured as follows. *Section three*, presents methodology employed. Discussion on findings is presented in the *section four*, in this part we deliberated on the results and compare with the findings in the previous studies. *Section five*, presents the conclusion and recommendations.

3. Methodology

We employed a widely used approach in examining the efficiency that is the Data Envelopment Analysis (DEA). Farrel (1957) advocated that the efficiency performance of any given firm consisted of technical efficiency and allocative efficiency. He further described the technical efficiency as the ability of the firm to maximize outputs given the set of inputs, or minimizes the inputs for a production of the given level of outputs. On the other hand, allocative efficiency was defined as ability of the firm to use the inputs mix in optimal proportions given the prices. Therefore, in this study we focus on the technical efficiency of the teaching hospitals in Tanzania, which is the ability of teaching hospitals to maximize the outputs given the set of inputs or minimize the inputs for a production of a given level of outputs. Although there are different methods (such as ratio as well as regression analysis) that can be used in estimate efficiency, we ended up choosing a non-parametric DEA approach because of its advantages over the parametric approach in estimating the hospitals efficiency.

Several studies on hospitals efficiency employed DEA and stochastic frontier analysis (SFA), both in developing countries and developed countries (Gourdazi et al., 2014). DEA is a mathematical programming method to calculate efficiency and productivity. It allows the comparison of efficiency score against the estimated efficient frontier. Unlike SFA, DEA is a non-parametric deterministic approach which estimates efficiency based on multiple productivities. The best practices efficient frontier is established by DEA through joined piece

wise linear established based on the linear programming (Gourdazi et al., 2014; Al-Shammari, 1999; Farrel, 1957). In measuring efficiency of teaching hospitals DEA has been used in the following studies, Lob et al. (2009), they employed DEA to measure the performance of Brazilian University hospitals, using the sample of 30 hospitals. Moshiri et al. (2011) used DEA to examine the efficiency of teaching hospitals in Malaysia.

3.1 Dataset and Data Sources

Data were obtained from the annual reports of respective hospitals under the study, the study covered period of 2009 – 2013. Most of these private teaching hospitals are faith-based, therefore they are obliged to prepare annual reports and submit to the office of the Christian social service commission (CSSC) head quarter. We employed a sample of 16 hospitals included: Muheza Hospital, Sumve Hospital, Sikonge Hospital, Nkinga Hospital, Makiungu Hospital, Bukumbi Hospital, and ST. Corneleous Hospital. Other hospitals were Mvumi Hospital, Sengerema Hospital, Rubya Hospital, Kolandoto Hospital, Kilema Hospital, Machame Hospital, Peramio Hospital, Mbozi Mission Hospital and Bunda Hospital. The study period covered period 2009 -2013 (5 years), selection hospitals based on the flexibility and completeness of the data required to allow the balanced panel. Data was extracted from the annual hospital reports for the period under the study.

3.2 Model and Variables Specification

DEA approach involves different assumptions employed when performing the efficiency measure of the DMUs under the study. For example, variables returns to scale (VRS) and constant returns to scale (CRS) or input oriented and output oriented according to Hollingsworth (2008). In this study we build on Lobo et al. (2010) and adopt the variable return to scale (VRS) and output-oriented model in evaluating the efficiency of private not for profit teaching hospitals in Tanzania. The study used two types of variables namely; inputs and outputs. Inputs variables are those used to produce hospitals outputs (beds and employees), while outputs variables are the results of the hospitals operating activities (such as discharged patients, outpatients' visits, number of admissions, number of surgeries, births, etc.). In specifying variables we followed Moshiri et al. (2011) who examined teaching hospitals in Malaysia and Gourdazi et al. (2014) who examined teaching hospitals in Iran. We used number of doctors, number of nurses, non-medical staff and number of beds as the inputs. On the other hand, we used the inpatients admissions and the number of outpatients visits as the outputs **(Ref Table 1)**. It is assumed that both outpatients' visits and emergency were considered as outpatient admission.

Table 1. Input and Output Variables for DEA

Outputs	**Output operational definitions**
Total inpatients discharged	Total number of inpatients treated and discharged during the year 2009-2013.
Total outpatients visits	Total number of outpatients visited the departments during 2009-2013
Inputs	**Inputs operational definitions**

Licensed hospitals beds	Total Number of actually used Hospital beds during 2009-2013
Number of Doctors	Total Doctors and number of full-time physicians 2009-2013
Number of Nurses	Total number of Nurses (full time) per year 2009-2013
Number of non-medical	Total number of non-medical staff per year 2009 -2013

3.3 Technique of Data Analysis

DEA technique is the appropriate technique for resource evaluation among healthcare organizations (such as hospitals) which provides how to improve hospitals efficiency and avoid wastage of healthcare resources (Sherman, 1986).

For each teaching hospital there is a vector which is associated with set of inputs and outputs. Given the stated assumptions, we can formulate equations which defines J^{th} technical efficiency of teaching hospitals in Tanzania.

Maximize efficiency for $DMU_o = \theta = \sum U_r Y_{rjo}$

Subject to: $\sum U_r Y_{rj} - \sum V_j X_{ij} \leq 0$

$$\sum V_j X_{jo} = 1$$

$$UV \geq 0$$

Where

Yrj – the amount of output ***r*** produced by hospitals ***j***

Xij – the amount inputs ***i*** used by hospitals ***j***

Ur – The weight given to output *r (r = 1…t* and *t is* the number of outputs)

Vi – the weight given to inputs *i* (*i*=1…*m* and *m* is the number of inputs)

N – The number of hospitals

jo – the teaching hospitals under the scrutiny.

In other studies performance indicators employed in analyzing the teaching hospitals include: *ALOS (average length of stay), bed turnover, employees productivity.* Generally patients care in a teaching hospitals is provided by team of medical professionals including physician's fellow residents and medical students (Huckman et al., 2014). Therefore with the same line of argument absence or presence of residents may have impact on the efficiency or productivity of hospitals, as Batt (2002) argued that small employees turnover may have cause decline in productivity, and (Kackmar et al., 2006) worsen customer services.

4. Findings and Discussion

It is true that hospital's size or scale of hospitals' activities may have impact on its performance or efficiency. Therefore, in this part of study we present the result on technical and scale efficiency *(Ref: Table 3 and Appendix 1).* The teaching hospitals will be regarded as efficient if the efficiency score 1 comparatively to others, higher production/outputs for fixed amounts of inputs (such as Nurses, Doctors, and non-medical staff and hospitals beds). From the set of DMUs with best practices activities, DEA establishes an empirical production frontier with the level of efficiency ranging between 0.00 and 1.00 representing the distance between the DMUs' efficiency scores and the efficiency frontier. **Table2** Presents the descriptive statistics for the inputs and outputs variables of 18 teaching hospitals included in this study.

Table 2. Summary Statistics for Outputs and Inputs

Variable	Obs	Mean	Std. Dev.	Min	Max
discharged~s	90	8817.2	5456.683	249	24060
totaloutpa~s	90	59549.97	72654.73	3014	362907
numberofbeds	90	215.1333	59.12512	150	317
doctors	90	16.56667	13.02983	5	83
totalnumbe~e	90	83.07778	42.37559	28	256
nonmedical~f	90	129.2889	33.52351	60	220

Technical efficiency score of 18 teaching hospitals (TH_{1-18}) from the year 2009 – 2013 are presented **in Table 3.** Arithmetic average of each hospital is presented in the last column. Finding shows that out of 18 teaching hospitals employed in this study, only 2 (11.11%) hospitals (TH-11 and TH-16) were close to technical efficiency, as they were operating at 98% (0.98) level of technical efficiency. The remaining 16 (88.88%) hospitals were operating below 95% (0.95) level of technical efficiency. However, two hospitals (TH-12 and TH-15) were operating at the level of 94.6% and 92.7% respectively. We further found that 3 (16.6%) hospitals were operating below the average of 50%. Specifically, teaching hospitals with average technical efficiency above 90% were TH-11, TH-12, TH-15 and TH-16, remaining were manifesting below average technical efficiency of 90%.

In a previous study by Moshiri et al. (2011) DEA was used to assess the efficiency of teaching hospitals in Malaysia, the result showed that mean efficiency score in hospital I was 76 %, hospitals II was 92% and hospital III was 75%. When mean efficiency in hospitals I, II and III are compared to this study we found that on average teaching hospitals TH-11, TH-12, TH-15 and TH-16 in Tanzania have higher mean technical efficiency which is higher than the teaching hospital I, II and III in Malaysia. However, the three hospitals (in Malaysia) have higher mean technical efficiency compared to the remaining 14 teaching hospitals in Tanzania.

In a similar study by Gourdazi et al. (2014) examining technical efficiency of teaching hospitals in Iran, it was revealed that teaching hospitals in Iran has mean technical efficiency score of 59% (ranging between 22% to 81%), in Tanzania a mean level of technical efficiency for teaching hospitals is 57% (ranging between 21.19% to 98%). Therefore the mean level of technical efficiency of teaching hospitals in Tanzania (57%) is less than that of Iran (59%). During the period under the study (2009 – 2013), the mean level of technical efficiency decreased from 0.57% (0.57) in 2009 to 52.7% (0.527) in 2013, this is contrary to the teaching hospitals in Iran where it was found that there was increase in the mean level of technical efficiency from 61% to 71%. Generally, this implies that there was increase in wastage in healthcare resources from 43% in 2009 to 47.3% in 2013 in the process of either healthcare services delivery, research or Training in the private teaching hospitals in Tanzania.

In the findings reported by Lobo et al. (2010) examining efficiency of teaching hospitals in Brazil. It was reported that, efficiency of hospitals assessed varied between 0.19 (19%) and 1.00 (100%), with mean of 0.54 = 54%. The dimensional score showed that hospitals prioritizes the gain in health care efficiency. This is contrary to the finding in our study where the mean level of technical efficiency is 57% (ranging from 21.19% to 98%). Therefore the mean level of technical efficiency of teaching hospitals in Tanzania (57%) is greater than the mean level of technical efficiency of teaching hospitals in Brazil.

In the result reported by Rosko (2004), it was found that on average inefficiency of teaching hospitals in US declined from 14.35% in 1990 to 11.42% in 1998 and increased to 11.78% in 1999. Compared to our study, firstly, there is an increase of average efficiency for the first three years, from 57% in 2009 to 60% in 2011, this was followed by a decrease from 60% in 2011 to 56.9 in 2013 (Ref. Figure 1). It is obvious that there are other factor apart from the teaching status which influence the performance of the hospitals. In the findings reported by Ayanian, and Weissman, (2002) it was found that, factors related to organizational culture, staffing, technology and volume may lead to performance. However, the focus of this paper was the technical efficiency in teaching hospitals in Tanzania.

Table 3. Technical Efficiency Scores and Arithmetic average

	2009	2010	2011	2012	2013	Average
TH-1	0.62235	0.685644	0.817553	0.824333	0.87705	**0.765386**
TH-2	0.062701	0.234696	0.324045	0.228728	0.542436	**0.278521**
TH-3	0.739941	0.723286	0.824702	0.430265	0.483168	**0.640272**
TH-4	0.435662	0.48001	0.516784	0.286006	0.095395	**0.362771**
TH-5	0.344642	0.715319	0.674233	0.101905	0.327686	**0.432757**
TH-6	0.45791	0.302438	0.334878	0.34707	0.084088	**0.305277**
TH-7	0.320727	0.176391	0.242201	0.1824	0.137845	**0.211913**
TH-8	0.413112	0.477603	0.398525	0.363956	0.398375	**0.410314**
TH-9	0.358689	0.355541	0.386531	0.34634	0.418851	**0.37319**
TH-10	0.678245	0.669955	0.71208	0.663685	0.244102	**0.593613**
TH-11	0.900185	1	1	1	1	**0.980037**
TH-12	0.96242	0.871458	0.92729	1	0.9729	**0.946814**
TH-13	0.704381	0.628058	0.580937	0.647373	0.674306	**0.647011**
TH-14	0.701004	0.673576	0.553192	0.560256	0.62761	**0.623128**
TH-15	0.898219	0.860662	0.917387	1	0.962702	**0.927794**
TH-16	0.929147	1	1	1	1	**0.985829**
TH-17	0.417831	0.463759	0.444842	0.43947	0.283949	**0.40997**
TH-18	0.371171	0.391667	0.286615	0.330214	0.363147	**0.348563**
Mean level of TE	**0.573240**	**0.595004**	**0.607878**	**0.541778**	**0.527423**	**0.569065**

Note: TH – Teaching hospitals (hospitals' name has been replaced by TH).

As far as scale efficiency is concerned, *appendix 1* provides the result. The result shows annual mean scale efficiency of private teaching hospitals in 2009, 2010, 2011, 2012 and 2013 were 78.5%, 83.8%, 83%, 84.1% and 82% respectively, meanwhile the overall mean scale efficiency over the study period was 82.4%. The result implies that over the study period private teaching hospitals in Tanzania were operating below their optimal size by an average of 17.6%. Over the study period the hospital with lowest average scale efficiency score was TH_2 (average scale efficiency of 28%) while the highest was TH_{16} and TH_{12} (both with average scale efficiency of 99.6%).

4.1 Limitation of the Study

One of limitation of this study is that due to data limitation we were not able to measure the health outcomes such as patient safety, mortality rate, and the quality of care and patient satisfactions. In measuring teaching hospitals efficiency the case mix index was not taken into account. To take care of this, we followed Gaurdazi et al. (2014) and used the inpatient admissions instead of a hospitals outputs.

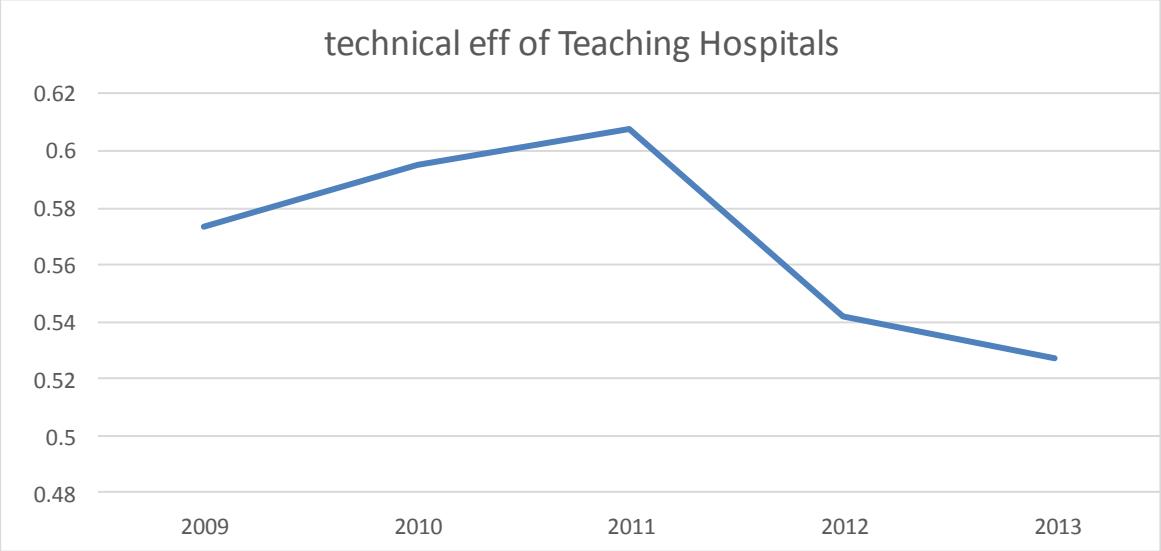

Figure 1. Mean level of Technical Efficiency 2009-2013

5. Conclusion and Policy Implications

Resource reallocation is necessary in order to realize the efficiency, however this should be taken with care as all three aspects (traditional function of health care delivery, teaching and research) affect each other in most teaching hospitals. As Shahian et al. (2012) contended, teaching hospitals offer advanced clinical capabilities, educate the next generation of providers of healthcare as well as undertaking research and innovation. It is very important (for government, policy makers, hospitals' managers) to put the aspect *technical efficiency* as the priority in operation of the teaching hospitals as it largely determine the future of health care system of the country. Since there are healthcare resources which are wasted through health care delivery process, teaching or research activities it means there is greater potential for efficiency improvement of efficiency in Tanzania teaching hospitals. Teaching hospitals can increase their outputs with the existing resources and significantly increase contribution to healthcare delivery, teaching and research in their catchment areas. Future similar study should focus on the association of the teaching intensity (or other variables) and performance of the teaching hospitals in Tanzania. Further studies should also include public teaching hospitals so as to provide basis of comparison between the public and private teaching hospitals in Tanzania.

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Appendix

Appendix 1. Scale Efficiency

	2009	2010	2011	2012	2013	Average
TH-1	0.800576	0.791581	0.817553	0.84766	0.87705	**0.826884**
TH-2	0.074099	0.234696	0.32755	0.228728	0.542436	**0.281502**
TH-3	0.890269	0.920423	0.88534	0.930568	0.923895	**0.910099**
TH-4	0.929226	0.927782	0.906884	0.884902	0.757719	**0.881303**
TH-5	0.850895	0.864567	0.835308	0.828191	0.764639	**0.82872**
TH-6	0.45791	0.880955	0.892057	0.87623	0.896145	**0.800659**
TH-7	0.320727	0.536239	0.329588	0.275106	0.236318	**0.339596**
TH-8	0.77234	0.764118	0.815136	0.870296	0.794908	**0.80336**
TH-9	0.755292	0.852127	0.875042	0.982219	0.992188	**0.891374**
TH-10	0.678245	0.669955	0.71208	0.663685	0.244102	**0.593613**
TH-11	0.980805	1	1	1	1	**0.996161**
TH-12	0.96242	0.871458	0.92729	1	0.997109	**0.951655**
TH-13	0.964917	0.952965	0.95802	0.936328	0.96521	**0.955488**
TH-14	0.900613	0.931811	0.839709	0.853272	0.840931	**0.873267**

TH-15	0.920455	0.973488	0.943889	1	0.973729	**0.962312**
TH-16	0.979787	1	1	1	1	**0.995957**
TH-17	0.95113	0.957232	0.971459	0.974757	0.970319	**0.964979**
TH-18	0.939851	0.956543	0.998751	0.992366	0.954144	**0.968331**
Mean	**0.784975**	**0.838108**	**0.835314**	**0.84135**	**0.81838**	**0.823626**