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WAQF INPUTS AND OUTPUTS IN MEASURING TECHNICAL EFFICIENCY USING DATA ENVELOPMENT ANALYSIS (DEA): A SYSTEMATIC REVIEW

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Abstract: *In measuring the technical efficiency of Waqf institutions, several methods can be applied, with Data Envelopment Analysis (DEA) being one of the most prominent. Despite its widespread use, DEA has certain limitations. One significant limitation is its sensitivity to the selection of inputs and outputs, which can greatly influence the results. Therefore, it is crucial to identify the appropriate inputs and outputs for measuring the technical efficiency of Waqf institutions using DEA to ensure the accuracy of the results. This study aims to identify the inputs and outputs commonly used in measuring the technical efficiency of Waqf institutions using DEA. The research methodology involved a systematic review of relevant studies. Two databases, namely Scopus and Google Scholar, were utilized for searching articles published between 2014 and 2024. Sixteen studies were reviewed and assessed in the final stage. In conclusion, researchers commonly consider inputs in analyzing the technical efficiency of Waqf institutions using Data Envelopment Analysis (DEA) including financial resources, such as total donations and operating costs, and human resources, such as the number of employees and volunteers. Other inputs often include physical assets like the number of properties or facilities owned by the Waqf institution. On the other hand, the outputs typically considered in these analyses include the number of beneficiaries served, the number of programs or services provided, and the impact or outcomes of these services, such as improvements in community well-being or educational achievements. Other outputs may include the total revenue generated from Waqf properties and the utilization rates of these properties. This study has identified the commonly used inputs and outputs in measuring the technical efficiency of Waqf institutions using DEA. These insights can guide future research. However, the selection of inputs and outputs should align with the specific objectives and context of the Waqf institution to ensure accurate and meaningful efficiency assessments.*

Keywords: *Waqf efficiency, Waqf performance, Waqf productivity, benchmarking Waqf, Data Envelopment Analysis, DEA*

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Introduction

There are numerous studies on technical efficiency across various types of institutions worldwide, driven by the need to use resources efficiently. Technical efficiency, as defined by Farrell (1957), is about producing the maximum output from a given amount of input or producing a given output with the minimum input. It reflects the producers' choices in allocating resources to maximize outputs from given inputs or to minimize inputs for a given level of output, and it can be either output-oriented or input-oriented (Herindar & Rusydiana, 2021).This concept of technical efficiency can be applied to any organization, including Waqf institutions.

Waqf institutions play a crucial role in the socio-economic development of communities. Measuring the efficiency of waqf institutions has garnered interest among researchers due to the increasing demand for transparent and effective management of waqf assets in recent years (Yakob et al., 2023). Despite their services often being targeted toward specific segments of the population, waqf institutions manage substantial resources and funds. These institutions are responsible for allocating and utilizing a significant portion of their endowments to fulfill their charitable and social obligations. This underscores the importance of optimizing resource allocation and enhancing technical efficiency to maximize the impact of waqf assets and ensure their sustainability (Senjiati & Yadiati, 2021). Measuring the efficiency of waqf institutions using DEA presents challenges in identifying and standardizing the inputs and outputs that accurately reflect their performance. Waqf institutions operate with unique characteristics, where their resources (inputs) and the social and economic impacts (outputs) they generate can vary significantly (Hasan et al., 2020).

Over the years, researchers have shown a growing interest in assessing the efficiency of these institutions. Several methods are available to measure technical efficiency, which can broadly be categorized into non-parametric and parametric approaches (Kim & Lee, 2018). Among these, Data Envelopment Analysis (DEA) is a commonly used non-parametric approach, (Hasan et al., 2020; Ibrahim & Ibrahim, 2020; Misbahrudin, 2019; Putri, 2022; Pyeman et al., 2016; Yakob et al., 2023). DEA has become a preferred method for many researchers when evaluating the technical efficiency of Waqf institutions due to its advantages, such as the ability to handle multiple inputs and outputs without requiring a specific functional form for the production process.

Therefore, this study was conducted to find out common knowledge in the empirical studies on DEA applications within waqf institutions to identify the most commonly used inputs and outputs, as well as the areas that require more attention for future research. The systematic literature review (SLR) technique was applied and the article selection and findings were reported according to the PRISMA guidelines. The findings of this study aim to support the development of a standard set of criteria for designing and implementing DEA in waqf institutions, which could be instrumental in standardizing DEA outcomes. This study represents a step toward establishing DEA as the most widely used tool for enhancing the efficiency of non-profit organizations and contributes to refining DEA as a methodology.

The remaining sections of this paper are structured as follows: Section 2 provides a wide overview of the literature review. Section 3, the methodology outlines how the literature review was carried out and analyzed systematically. Section 4 explains the results of the study. In section 4, discussion practicality and research implications are outlined. Finally, the section 5 concludes the paper.

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Literature Review

Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric method that uses mathematical programming to solve a set of problems by maximizing or minimizing a given objective under certain constraints (Sarafidis, 2002). DEA was initially developed by Charnes, Cooper, and Rhodes to measure and compare the relative efficiency of a set of decision-making units (DMUs) (Sengupta, 2012). The classical DEA model can be represented as:

Efficiency = Output / Input

DEA utilizes two main frameworks: the Constant Returns to Scale (CRS) model and the Variable Returns to Scale (VRS) model (Hasan et al., 2020). In the CRS model, producers can scale inputs and outputs linearly without affecting efficiency (Hasan et al., 2020). The VRS model, developed by Banker, Charnes, and Cooper, allows for varying returns to scale, meaning that as an organization changes its scale of operations, its efficiency may increase or decrease (Banker et al., 1984).

DEA has several strengths that contribute to its popularity among researchers. One key advantage is its ability to handle multiple inputs and outputs with different units of measurement (Kahraman & Tolga, 1998). Additionally, DMUs are compared directly against a peer or a combination of peers (Kahraman & Tolga, 1998). However, DEA also has some limitations. It does not account for error estimation, interpreting any deviation from the efficiency frontier as inefficiency (Bezat, 2009). DEA is also highly model-specific, with efficiency measurements varying depending on whether the model is input-oriented or output-oriented and the variables specified (Bezat, 2009). Furthermore, DEA estimates relative efficiency within a sample, reflecting the dispersion of efficiencies only within that sample (Bezat, 2009). In the context of Waqf institutions, DEA can be particularly useful for assessing the efficiency of these organizations in utilizing their resources to maximize their social and economic impact. The ability to handle diverse inputs and outputs aligns well with the varied activities and goals of Waqf institutions, making DEA a valuable tool for their efficiency analysis.

Method

Search Strategy

To assess the efficiency of Waqf institutions using DEA, relevant inputs and outputs were identified from published literature and hardcopy resources. The databases were searched for studies published from January 2014 to the present. For this systematic review, searches were conducted in Scopus and Google Scholar databases. Scopus, one of the largest abstract and citation databases of peer-reviewed literature, includes over 24,600 journals from 5,000 publishers worldwide, covering diverse subjects such as environmental sciences, social sciences, agriculture, and biological sciences (Salisbury, 2009). Meanwhile, Google Scholar (GS) is a widely used web-based academic search engine that catalogs between 2 and 100 million records, including both academic and grey literature (articles not formally published by commercial academic publishers). GS aggregates results from across the internet and is free to use. Consequently, it has garnered significant attention as a valuable tool for literature searches especially for systematic reviews (Haddaway et al., 2015). Since the search for the topic of waqf efficiency on Scopus databases came out with very little results, this study resorted to using Google Scholar which is also an acceptable database as it stores reputable indexed articles

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from Scopus and ISI. A series of search strings was used to identify relevant articles, including keywords such as "efficiency*", "performance*", "productivity*", "benchmark*", "data envelopment analysis*", "DEA*", "waqf*" and "Islamic endowment*" (see Table 1). Although backward and forward snowballing, as proposed by Wohlin (2014), is an effective article search method, it was deemed inappropriate for this study, which focuses solely on articles within the Scopus and Google Scholar databases.

Table 1: The Search String Used for the SLR Process

Databases	Keywords Used
Scopus	TITLE-ABS-KEY ("efficiency*"OR "performance*"OR "productivity*", "benchmark*"OR "data envelopment analysis"OR "DEA*"AND "waqf" OR "Islamic endowment*")
Google Scholar	"efficiency" OR "performance" OR "productivity", "benchmark" OR "data envelopment analysis" OR "DEA" AND "waqf" OR "Islamic endowment*"

Inclusion and Exclusion Criteria

This study established inclusion and exclusion criteria based on publication type, language, timeline, and indexing. The primary goal of this process is to ensure that all selected articles meet these criteria (Kitchenham, 2011; Mohamed Shaffril et al., 2021; Sierra-Correa & Kintz, 2015). Regarding publication type, only journal articles were selected, excluding review papers, book series, books, book chapters, and conference proceedings. The search was focused on articles published in English, specifically in the Scopus and Google Scholar databases. The timeline for the publication year of journal articles was set from the earliest possible year, 2014, to the present, aligning with the establishment of the databases used. According to Loh & Sun (2019), an unrestricted publication year ensures a comprehensive review. Lastly, the study was limited to those focusing on quantitative approaches in waqf studies, excluding qualitative and mixed methods. The inclusion and exclusion criteria are summarized in Table 2.

Table 2: Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication type	Journal (research articles)	Review papers (systematic review or meta-analyses), book series, book, chapter in book, and conference proceeding
Language	English	Other than English
Resource	Scopus and Google Scholar	Not available via Scopus and Google Scholar databases
Timeline	Between 2014 until 2024	<2014
Nature of study	Quantitative approach using (Data Envelopment Analysis or DEA)	Qualitative approach and mixed method

Quality Assessment and Extraction

One reviewer screened the title, abstract, and full text of each retrieved article. To ensure consensus on the included articles, a panel of experts reviewed the relevance of the articles. The main researcher extracted the data, and duplicated publications were identified and removed by comparing the authors' names, study titles, and years of publication.

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Data Synthesis

The results were synthesized and summarized within a logical framework. This framework presents the various findings and narratively categorizes the studies based on the number and types of waqf, the inputs and outputs used, and the findings of the studies.

Results and Discussion

Initially, the search yielded a total of 200 articles from two databases. The search process involved evaluating the titles followed by the abstracts. Articles were excluded from further review if the titles or abstracts did not align with the study's objectives. After screening for eligible articles based on the inclusion criteria, only 16 full-text articles were included in the final review stage. Figure 1 illustrates the search strategy flow diagram. The assessments were based on the articles' content, including the introduction, results, and discussion. Table 3 provides a summary of the inputs and outputs used in measuring the technical efficiency of waqf institutions using DEA.

Flowchart of The Search Strategy

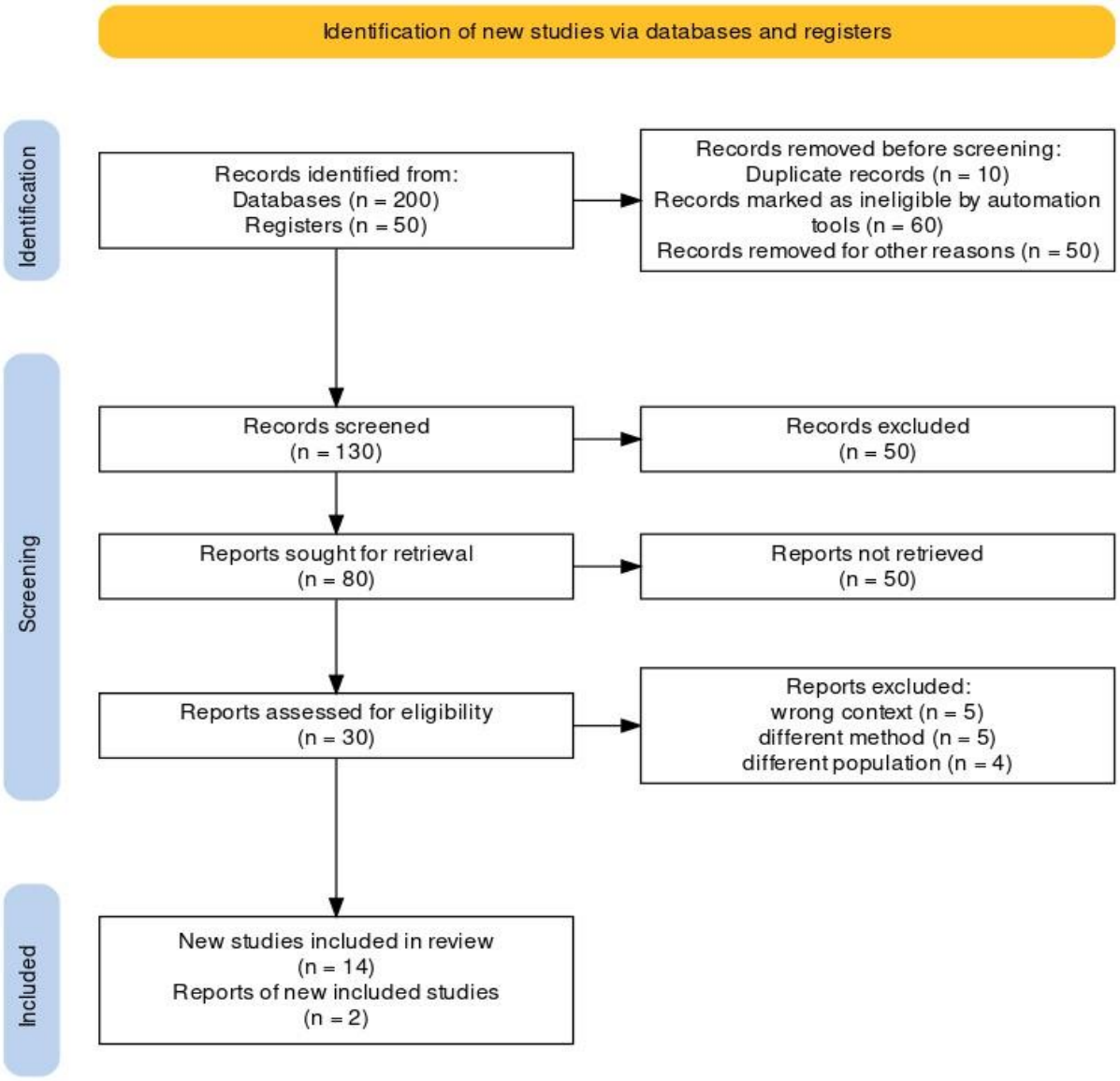

Figure 1: PRISMA Flow Diagram on The Process of Study Selection

Source: Haddaway et al., (2022)

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Table 3: Summary of Systematic Review on Waqf Inputs and Outputs In Measuring Waqf Technical Efficiency Using DEA

No	Author(s)	DMU	Variable (s)	
			Input (I)	Output (O)
1	Hasan, H., & ahmad, I. (2014)	Malaysian public waqf	I1=Waqf collection I2=Management information	O1=Waqf development projects and works
2	Pyeman et al., (2016)	Malaysian public waqf	I1=Number of staff I2=Total waqf funds from the government (WaqfJ)	O1=Value of Waqf project (WaqfP) O2=Waqf collected funds (WaqfC)
3	Misbahrudin, (2019)	13 Waqf institutions in Malaysia	I1=Total yearly expenditure of every SIRCs or its subsidiary	O1=Cash waqf O2=Land waqf
4	Bakri, (2020)	13 waqf institutions in Malaysia	I1=Number of officers employed I2=Number of agents banks I3=Collection expenses	O1=Waqf collection O2=Waqf distribution
5	Ibrahim & Ibrahim, (2020)	13 Waqf institutions in Malaysia	I1=Labor I2=Operating expenses I3=Fixed Assets	O1=Rental income O2=Investment income
6	Hasan et al., (2020)	Two states of Waqf institutions in Malaysia (Kelantan and Penang)	I1=Assets (building and structures) I2=Labor (*mutawallis,nazirs*)	O1=Social services
7	Senjiati & Yadiati, (2021)	8 zakat institutions that manage waqf fund in Indonesia	I1=Operational costs I2=Depreciation costs	O1=Revenue O2=Utilization of waqf funds
8	Yakob et al., (2021)	13 Waqf institutions in Malaysia	I1=Labor I2=Total expenses	O1=Total number of staff
9	Ibrahim et al., (2021)	13 Waqf institutions in Malaysia	I1=Labor I2=Operating expenses I3=Total Asset	O1=Rental income O2=Investment income
10	Juliana et al., (2022)	Private waqf institutions in Indonesia	I1=Waqf asset value I2=Operating costs I3=General and administrative expenses	O1=Fundraising O2=Revenue

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11	Rusydiana et al., (2022)	8 zakat institutions that manage waqf fund in Indonesia	I1=Operational costs I2=Human resource costs	O1=Funds collected O2=Funds distributed
12	Rusydiana, Herindar, et al., (2022)	8 zakat institutions that manage waqf fund in Indonesia	I1=Operational expenses I2=Human resource expenses	O1=Acceptance of waqf O2=Distribution of waqf
13	Maripatul Uula, (2022)	6 Zakat institutions that manage waqf fund in Indonesia	I1=Salary expenses I2=Operating expenses I3=Total assets	O1=Collected waqf funds O2=Distributed waqf
14	Maulida & Laila, (2023)	6 waqf institutions in Indonesia.	I1=Employee costs I2=Operational costs I3=Fixed assets	O1=Collection of waqf O2=Distribution of waqf.
15	Maulida & Abdurrahman, (2023)	6 waqf institutions in Indonesia,	I1=Operating costs I2=HR expenses I3=Fixed assets	O1=Waqf fund receipts O2=Waqf fund disbursements
16	Yakob et al., (2023)	11 waqf institutions in Malaysia	I1=Fundraising expenses I2=Staff salary expenses I3=Operating expenses	O1=Total collection of waqf funds O2=Waqf project value

Source: Author's Contribution

Waqf Inputs in Measuring Technical Efficiency Using Data EnvelopmentAnalysis

The inputs commonly used in measuring the technical efficiency of waqf institutions encompass a range of financial and human resource elements that reflect their operational capacity and expenditures. Across various studies, similarities and differences can be observed. Many studies use financial inputs to capture the monetary aspects of waqf operations. For example, operating costs, total yearly expenditures, and collection expenses are frequently utilized. Inputs such as total waqf funds from the government (Pyeman et al., 2016), total expenses (Yakob et al., 2021), and fundraising expenses (Yakob et al., 2023) reflect the financial investments and costs incurred by waqf institutions. Additionally, several studies emphasize the importance of human resources, using labor-related metrics. The number of staff (Pyeman et al., 2016) and labor costs (Ibrahim & Ibrahim, 2020; Hasan et al., 2020) are commonly used inputs, with specific roles such as mutawallis and nazirs also considered (Hasan et al., 2020). Operational costs are a recurring theme across multiple studies, reflecting ongoing expenditures necessary for the daily functioning of waqf institutions (Senjiati & Yadiati, 2021; Maulida & Laila, 2023).

However, there are also differences in the specific financial and operational elements chosen. Some studies include unique financial elements such as depreciation costs (Senjiati & Yadiati, 2021) or waqf asset value (Juliana et al., 2022), which are not uniformly applied across all

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studies. Fixed assets are considered by some researchers (Ibrahim & Ibrahim, 2020; Hasan et al., 2020) but not universally. Certain studies incorporate management-specific inputs, such as management information (Hasan & Ahmad, 2014) and general and administrative expenses (Juliana et al., 2022), which are less common in others. The classification and granularity of labor inputs also vary. For example, Hasan et al. (2020) differentiate between general labor and specific roles like *mutawallis* and *nazirs*, while others simply use a broad category of labor (Ibrahim & Ibrahim, 2020). Some studies include inputs unique to their specific context or focus, such as the number of agent banks (Bakri, 2020) or specific salary expenses (Maripatul Uula, 2022). Overall, while there is a common emphasis on financial and human resource inputs across studies, the specific elements chosen vary. This variability reflects the different operational focuses and data availability within the studied waqf institutions. The selection of inputs often aligns with the unique operational characteristics and strategic priorities of each waqf institution, leading to both shared and distinct inputs across the literature.

Waqf Outputs in Measuring Technical Efficiency Using Data Envelopment Analysis

The outputs used in studies measuring the technical efficiency of waqf institutions reflect their effectiveness in generating benefits and managing resources, showcasing both similarities and differences. Commonly, financial outputs such as the collection and distribution of waqf funds are emphasized. Studies like those by Pyeman et al. (2016), Misbahrudin (2019), and Yakob et al. (2023) focus on metrics such as waqf collected funds, cash waqf, land waqf, and the total collection of waqf funds, highlighting the financial performance of waqf institutions. Revenue-related outputs, including rental income and investment income, are also frequently used, as seen in the work of Ibrahim & Ibrahim (2020) and Ibrahim et al. (2021), alongside general revenue measures found in Juliana et al. (2022) and Senjiati & Yadiati (2021).

Service-related outputs are another common metric, with several studies measuring the effectiveness of waqf institutions in providing social services and projects. Hasan and Ahmad (2014) identified waqf development projects and works as key outputs, while Hasan et al. (2020) considered social services. Additionally, the utilization of waqf funds is a crucial output, focusing on how these funds are allocated and used. This is reflected in studies that measure the utilization and distribution of waqf funds, such as those by Senjiati & Yadiati (2021), Maripatul Uula (2022), and Rusydiana et al. (2022).

However, differences exist in the specific output measures used. Some studies employ unique metrics tailored to their research focus. For example, Pyeman et al. (2016) measured the value of waqf projects, while Yakob et al. (2021) used the total number of staff as an output, a less common measure. The scope of outputs also varies, with some studies focusing on broader metrics like the total value of waqf projects (Yakob et al., 2023), while others concentrate on specific measures such as waqf collection and distribution (Bakri, 2020). Additionally, some studies combine financial and service-related outputs to provide a more comprehensive measure of efficiency, as seen in the work of Ibrahim & Ibrahim (2020) and Ibrahim et al. (2021), who included both rental income and investment income. While financial performance, service provision, and fund utilization are common themes in measuring the technical efficiency of waqf institutions, the specific outputs used vary based on the unique characteristics and objectives of each study. This variability reflects the diverse nature of waqf institutions and the multifaceted approach needed to evaluate their efficiency effectively.

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Conclusion

Based on the assessment of the articles, it was found that various inputs and outputs are commonly used in studies measuring the technical efficiency of waqf institutions. The selection of these inputs and outputs is primarily guided by prior research or established determinants of technical efficiency within waqf institutions. Commonly used inputs in the technical efficiency measurement of waqf institutions using Data Envelopment Analysis (DEA) include total yearly expenditure, which encompasses the financial outlay of each waqf institution or its subsidiaries. Labor inputs, such as the number of staff (including *mutawalli, nazirs*, and other employees), are also critical. Other inputs frequently considered are operating expenses, fixed assets (including the value of waqf properties), administrative costs, and human resource costs. On the output side, several key indicators are used to assess the performance of waqf institutions. These include the total cash waqf received from donors and the total land waqf acquired. Financial performance metrics, such as rental income generated from waqf properties and investment income, are also significant outputs. Additionally, the completion of projects that benefit society, the amount of funds allocated for welfare and development (social services), and the collection and distribution of waqf funds are crucial outputs. While this study has identified these commonly used inputs and outputs for measuring the technical efficiency of waqf institutions with DEA, the selection of specific inputs and outputs must align with the unique objectives and operational context of each waqf institution. This alignment ensures that the efficiency measurements accurately reflect the institution's performance and its contributions to societal welfare.

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