Management Characteristics of Cambodian Microfinance Institutions: Operational Efficiency and Management Objectives [*]

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Abstract

It is difficult to decide how to measure the efficiency of microfinance institutions' management. This is because, different from other profit maximizing financial institutions, an essential management characteristic of microfinance institutions involves working toward greater access for the poor.

This paper seeks to describe the characteristics and efficiency of the management of microfinance institutions in Cambodia, in terms of microfinance institutions' specific objective of expanding access to the poor, by using the analytical methodology described in the work of Gutiérrez-Nieto et al. (2007), with respect to microfinance institutions in Latin America. The analysis was conducted in two steps: in Step 1, the operating efficiency indices of major microfinance institutions were measured, by conducting a Data Envelopment Analysis (DEA) using data from the National Bank of Cambodia's annual publications. Next, in Step 2, a principal component analysis was conducted using the efficiency indices measured in Step 1, and the management characteristics of each microfinance institution were analyzed.

According to the results of our analyses, although great diversity exists among microfinance institutions in Cambodia, (1) large-scale microfinance institutions exhibit higher overall efficiency, (2) approximately one-third of microfinance institutions are oriented towards access for the poor, and (3) access-oriented institutions also exhibiting high overall efficiency comprised less than one-fifth of all microfinance institutions. These results suggest a need for policy that promotes expanding the scale of microfinance institutions, while simultaneously maintaining their orientation toward access for the poor.

Key words: Cambodia, Microfinance Institutions, DEA, Principle Component Analysis

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1. Introduction

Although the Cambodian economy has faced numerous difficulties, the nation has maintained a high growth rate since the 2000s. However, the financial sector's healthy development has emerged as an important policy issue. Access to formal financial institutions is still inadequate in Cambodia, and demand exists for greater financial inclusion of small businesses and microenterprises, particularly in rural areas where economic development is delayed. There are calls for the establishment of a financial sector capable to mobilize and allocate funds efficiently and appropriately (IMF, 2011).

Despite the fact that commercial banks act as Cambodia's financial center, microfinance institutions carry the expectation of spreading and developing Cambodia's financial system. First, as Cambodia's financial system is undeveloped, many households and businesses in small towns and rural areas continue to have minimal access to formal financial resources[1]. Microfinance institutions play an important role in improving financial inclusion in these areas, and are expected to grow in the future. Second, microfinance institutions' existence is also garnering attention from financial institutions in their development and growth. Several cases have occurred in Cambodia in which microfinance institutions convert to commercial banks following the institution's growth.

However, some have highlighted the contradictory relationship between microfinance institutions' role in promoting poverty reduction through financial inclusion, and their development as a financial institution while sustaining such operations. According to Amenomori (2010), an overarching trend regarding Cambodian microfinance institutions is to strengthen management characteristics that focus on sustainable operations, while placing relatively lower importance on growth of the institution and its provision of financial services to the poor. The Cambodian government expects microfinance institutions to develop, and eventually convert to, commercial banks. An area of interest involves future changes to both the balance of service provisions to the poor, and maintaining growth as a financial institution.

Understanding the characteristics of actual Cambodian microfinance institutions'

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[1] Cambodia's nominal GDP per capita is one of the lowest in the Association of Southeast Asian Nations (ASEAN). The United Nations Committee for Development Policy classified Cambodia as a "least-developed country" in July 2014, under its accreditation criteria. According to the World Development Indicators, 11.3% of Cambodian citizens were living on USD 1.25 or less in 2010, and 40.9% were living on 2 dollars or less. Regional income disparities are also severe. According to the poverty profile report for the Kingdom of Cambodia, published by the Japan International Cooperation Agency (JICA), the household poverty ratio in the inland, or northern region is higher in comparison to the nation's coastal, or southern region. The population segment living at or below the absolute poverty line in 2007 was less than 1% in the nation's capital of Phnom Penh, 22% in other urban areas, and 35% in rural areas.

operations is necessary before considering their role. However, one point of difficulty in analyzing microfinance institutions is that these organizations, unlike other private financial institutions that pursue a rational management approach designed to maximize profits, conduct their activities to provide services to the poor for fostering reductions in poverty. Additionally, different microfinance institutions target different management objectives. Management principles in these institutions are not uniform, as they are an amalgamation of an institution that places importance on sustainable operations and ensuring profits, and an institution that emphasizes poverty reduction, but does not necessarily concern itself with maintaining profits. Therefore, when measuring the operating efficiency of microfinance institutions, the performance of efficiency measured will vary depending on whether factors of inputs and outputs are selected for assessment.

There have been several studies examining Cambodian microfinance institutions' operating characteristics Tahir et al. (2013) conducted a comparative study using Data Envelopment Analysis (DEA), which considered the operating efficiency of microfinance institutions in each of the five ASEAN nations, including Cambodia, as well as their operating sustainability and service provisions for the poor. Crawford et al. (2014) used the same DEA in their study, and identified a trend among Cambodian microfinance institutions indicating that institutions that placed greater emphasis on reducing poverty were less profitable than others. Okuda et al. (2014) also used the DEA to measure the operating efficiency and rate of technological progress in Cambodia's microfinance institutions, and observed that operational sustainability was a characteristic of microfinance institutions in comparison to commercial and specialized banks.

These studies have made the characteristics of Cambodian microfinance institutions increasingly clear. However, the issue of conducting a comprehensive and objective assessment of these characteristics remains insufficient due to the diversity of management objectives targeted by these institutions. Although Tahir et al. (2013) considered both operational sustainability as well as the provision of financial services to the poor, their study was limited to only a single combination of input and output choices, as it focused on an international comparison. Okuda et al. (2014) focused on comparing microfinance institutions and other types of financial firms; their study contained only an analysis of operational sustainability. Crawford et al. (2014) analyzed operational sustainability, service provisions for the poor, and differing management objectives, but applied only two methods of assessment regarding the selection of output and input factors.

Gutiérrez-Nieto et al. (2007), in accordance with microfinance institutions' characteristic to have extreme variety in their targeted management objectives, offered an objective method to analyze multifaceted selection of outputs and inputs, and utilized micro-data from thirty microfinance institutions in 8 Latin American countries. This study will apply this method to Cambodia, and will more comprehensively and systematically examine microfinance institutions' management characteristics, which have been partially described by prior studies, by utilizing data collected from the National Bank of Cambodia's annual publications. Specifically, this study measures the efficiency scores of thirty-four major microfinance institutions by using DEA, and then examines the multifaceted characteristics of these institutions by adopting principal component analysis to the efficiency scores obtained.

This paper uses the following structure: in Section 2, the operations of Cambodian microfinance institutions are explained, using descriptive statistics. Section 3 explains the analytical method used in reference to the work of Gutiérrez-Nieto et al. (2007). Obtained measurement results are described in Section 4, and Section 5 discusses an assessment of the microfinance institutions' management characteristics. Section 6 concludes.

2. Microfinance Institutions in Cambodia
2.1 Historical background

Although economic activity in Cambodia had been adversely affected by many years of civil war and the Khmer Rouge regime, which sought a primitive communist economic system, consistent economic reform oriented towards a market economy conversion continued after the Khmer Rouge's collapse (IMF, 2011; IMF, 2014). The Cambodian economy has maintained a high economic growth since 2000, and it can be posited that economic development has been finally entering a growth trajectory. Cambodia's real GDP growth rate has remained above 7% in recent years, with the exception of the aftermath caused by the Lehman shock in 2009, and the nominal GDP per capita rose above 1,000 USD in 2013, a three-fold increase from 2000[2].

The financial institutions started their business operation after the Khmer Rouge regime collapsed. The National Bank of Cambodia (NBC) was reestablished in 1979 and the first state commercial bank started business in 1980. The Cambodian government has committed to developing the nation's financial system, and in 1999

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[2] Major factors leading to economic growth include (1) expansion of export of gourmets to the United States and the European Union, (2) growth of the service industry due to increased foreign tourism, (3) booming construction and real estate industries, primarily in the capital city of Phnom Penh, and (4) increase in foreign investment.

enacted legislation concerning banking and financial institutions to establish a more stringent management and supervision framework to foster greater confidence. Further, with regard to rural finance, the rural development banks were established in 1998 as a state-owned financial institution to increase the provision of financial resources to microfinance.

The microfinance industry reached Cambodia in the 1990s, later than neighboring countries. Microfinance business opportunities arose following the end of the Cambodian civil war, and under the governance of the United Nations Transitional Authority in Cambodia (UNTAC), increasing number of foreign NGOs could conduct microfinance business activities in the country. The microfinance industry spread quickly in Cambodia, and although the total number of users of microfinance services did not exceed 44,000 people in 1994, the number rose above 200,000 people in 1998. Additionally, the Cambodian government, in accordance with its intent to commercialize microfinance and promote institutional finance integration, established a policy in 2000 requiring the licensing and registration of microfinance institutions, and in 2002 promulgated additional supplementary rules.

The Cambodian microfinance sector has become well developed, and in 2004, some began referring to these businesses as having reached a level of "industry" (Alip et al., 2010). Seventeen microfinance institutions had obtained formal licenses in August 2007, and thirty NGOs with microfinance operations had registered with the central bank. In addition, many NGOs and cooperative organizations also conducted microfinance operations, despite not having registered with the central bank (Amenomori, 2010). Some commercial banks, such as ACLEDA Bank, began their business as microfinance operations run by NGOs, and later reorganized as commercial banks after developing in scale.

2.2 Current situation

Currently, four categories of entities are capable of conducting microfinance operations in Cambodia: (1) commercial banks, (2) specialized banks, (3) licensed or registered microfinance institutions, and (4) registered non-governmental organizations (NGOs).

Entities conducting microfinance operations in Cambodia include not only microfinancial institutions but also some commercial banks, registered NGOs and cooperatives. According to policy set by NBC, any organization possessing loan assets valued at 1 billion riels or higher, regardless of status as a limited liability company, partnership, cooperative, or NGO, must obtain a license to conduct microfinance

transactions, and register as a microfinance institution. Licensed and registered microfinance institutions are required to regularly disclose various data describing the institution's activities, and also to report operational indices, such as deposit balances, shareholder structure, reserve funds, and liquidity ratio to the NBC (Amenomori, 2010). Currently, no legal policy framework is applicable to unregistered NGOs, and data concerning these organizations has not yet been compiled. Legislation is said to be under discussion that would limit these organizations to activities related to societal development, such as humanitarian support, social welfare, or other activities for the public good (Alip et al., 2010).

According to an annual report of the Cambodia Microfinance Association (CMA), the market for Cambodian microfinance has been rapidly growing in scale (CMA, 2014). The total amount of loans in the microfinance market rose from USD 500,000 in 2005 to USD 1.8 billion during the third quarter of 2014, a 36-fold increase over 9 years. The total number of borrowers increased from 350,000 in 2005 to 1.72 million in 2014, an approximate nine-fold increase over nine years. Deposit balances in the third quarter of 2014 amounted to 8.1 million USD, and there were 1.05 million account holders and 18,000 total institution employees.

A total of forty-five microfinance institutions were registered as CMA members in the third quarter of 2014. However, NBC's 2013 annual report contained data for only thirty-six microfinance institutions. This paper will investigate thirty-four major microfinance institutions, or non-NGO institutions, which have been licensed, registered, and approved by NBC, for which data has been fully available for analysis.

Table 1 illustrates the Cambodian microfinance institutions investigated in this analysis, in order of size of total assets held. Considering each individual microfinance institution's total assets and numbers of branches, institutions in Cambodia exhibit a broad range in terms of scale; PRASAC Microfinance Institution, the institution holding the greatest amount of assets, is over 1,000 times larger than Farmer Fin, the lowest-ranking institution. Large number of microfinance institutions operate on 100% foreign-owned capital, as there are almost no restrictions on foreign capital investment in Cambodia. Microfinance institutions in the following sections will be classified into three groups, for convenience in comparing their asset size-dependent characteristics: the top eight institutions, with respect to total assets, will be classified as "large-scale microfinance institutions," and the bottom fifteen firms will be classified as "small-scale microfinance institutions." Microfinance institutions with foreign capital ownership of 51% or higher will be classified as "foreign microfinance institutions" for the purpose of convenience, in the same fashion.

Table 1. Operating Indices of Microfinance Institutions

2.3 Policy issues

Microfinance institutions carry the expectation of spreading and developing Cambodia's financial system. First, microfinance institutions are expected to play an important role in improving financial inclusion. Second, microfinance institutions are expected to become grown into a large financial institutions such as commercial banks.

Cambodian government has acted to move NGOs providing informal financial services and unregistered microfinance institutions into regulated markets, and has established a policy framework that requires these entities to become licensed and registered microfinance institutions or commercial banks. According to Amenomori (2010), the Cambodian government is working to adopt policies designed to promote the conversion of NGOs to licensed and registered microfinance institutions, as well as the eventual conversion of these institutions to commercial banks. For example, ACLEDA Bank, a commercial bank originally developed as an NGO, converted its status from NGO to licensed and registered microfinance institution in 2000. Further, in 2003, ACLEDA reorganized as a commercial bank, and today is one of Cambodia's largest banking companies. In other cases, licensed and registered microfinance institutions, such as Vision Fund Cambodia (VFC), Hattha Kaksekar Limited (HKL), Samic microfinance (previously CHC), and Seilanithih microfinance, were originally microfinance divisions of NGOs that reorganized as companies later, and began operating separately and independently.

The process of licensing and registration of microfinance institutions, and their subsequent reorganization as commercial banks, is said to have caused changes in the client base served. According to Amenomori (2010), Cambodian microfinance institutions have generally shifted from non-profit status, to for-profit businesses. The client base for nonprofit organizations, such as NGOs and unregistered microfinance institutions that originally focused their operations on the extremely poor or those with disabilities, is shifting in accordance with this trend, from these population segments to the non-impoverished, or those facing moderate to mild poverty, as these organizations place a greater focus on profitability.

3. Previous Studies

Microfinance institutions seek to expand access to financial services to the poor to reduce poverty. Another aspect of microfinance institutions is that, in contrast, they

aim to maintain the sustainability of their operations and work towards establishment as independent businesses. The management structures of microfinance institutions vary widely. If these institutions' expansion of access to financial services to the poor can be described as placing emphasis on "outreach," then the business independence-oriented aspect can be described as focusing more on "sustainability." Therefore, if different types of microfinance institutions are grouped together when measuring these institutions' operating efficiency, the purpose of the comparison exercise will be lost, as management bodies with entirely different objectives will be compared. This challenging issue appears when comparing the operating efficiency of microfinance institutions.

There have been several studies examining the efficiency of business operations of Cambodian microfinance institutions. Tahir et al. (2013) conducted a comparison that considered both operational sustainability and service provisions for the poor, using DEA with respect to microfinance institutions' operational efficiency in the five ASEAN countries, including Cambodia. Crawford et al. (2014) used the DEA method to describe a trend of reduced profitability among Cambodian microfinance institutions, placing a greater emphasis on poverty reduction. Okuda and Chia (2013) also measured management efficiency and the rate of technological progress in major Cambodian financial institutions by using this DEA method, and observed that in comparison to commercial and specialized banks, operational sustainability is the characteristic more associated with microfinance institutions.

Although these studies have illuminated the management characteristics of microfinance institutions and operational efficiency in Cambodia, an issue remains of conducting a comprehensive and objective assessment of these characteristics, due to the diversity of management objectives targeted by individual institutions. The study by Tahir et al. (2013) considered both operational sustainability and the provision of financial services to the poor; however, their study was limited to only a single combination of output and input factors as it focused on an international comparison. Okuda and Chia (2013) focused on comparing microfinance institutions against other types of financial firms, and their study was a comparative analysis of operational sustainability. The study by Crawford et al. (2014) focused on the analysis of operational sustainability and service provisions for the poor, which are contrasting management objectives, but their study applied only two types of assessment with regard to output and input factor selection. Despite these prior studies, analysis of the management characteristics of microfinance institutions remains inadequate.

Analysis of microfinance institutions that possess diversified management

structures often involves the grouping of similar institutions based on operational indicators from predetermined analytical viewpoints. However, regardless of the method applied, the arbitrary aspect of this group classification cannot be eliminated. The study conducted by Gutiérrez-Nieto et al. (2007) considered microfinance institutions' characteristic of broad variations in management goals and offered an objective analysis of multifaceted selection of output and input factors, using micro-data from thirty microfinance institutions in eight Latin American countries. Gutiérrez-Nieto et al. (2007) avoided specifying a predefined combination of input and output choices from specific viewpoints, which was the commonly adopted methodology in previous studies. Instead, in the first step of their analysis, they involved the all possible selections of input and output, including both outreach-oriented and sustainability-oriented choices. They measured DEA-based efficiency score of microfinance institutions with respect to all combinations of input and output choices, or "specifications" in their terminology. Next, in the second step of their analysis, by conducting a principal component analysis (PCA) of each specification's measured DEA score, they examined how operational efficiency aspects of microfinance institutions pertained to the diversified management targets of individual institutions. The study succeeded in offering a discussion of the differences regarding the management efficiency of outreach-oriented and sustainability-oriented microfinance institutions.

According to this analysis, the management characteristics of Latin American microfinance institutions are influenced by four principal components: (1) the overall measure of efficiency considering both outreach-oriented and sustainability-oriented management objectives, (2) the degree of emphasis on outreach and NGO status, and (3) intensity of input factors in business operations.[3]

4. Analytical Method
4.1 Measurement of operational efficiency using DEA

The tow step methodology applied by Gutiérrez-Nieto et al. (2007), that is, measuring the efficiency of all possible combinations of input and output choices in the

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[3] As Gutiérrez-Nieto et al. (2007) targeted microfinance institutions in several countries, there is a possibility that efficiency scores reflecting management environments that may differ by country will be assessed together. An analytical technique for determining relative efficiency, DEA is conducted on the premise that the operating environments of the institutions in the comparison sample are similar. Additionally, because monetary policy and level of economic development both vary by country, differences in management characteristics may also vary by nation in the analysis results.

first step (Step 1) and then distinguishing those institutions with similar characteristics in the second step (Step 2), allows systematic and comprehensive data analysis.

Following Gutiérrez-Nieto et al. (2007), this paper will conduct the two-step analysis by using the DEA and principal component analysis. Operational efficiency, as demonstrated by microfinance institutions, will differ depending on the selection of input and output factors. Therefore, the first step of the analysis involves measuring the operational efficiency of microfinance institutions with respect to all possible combinations of input and output factors, to eliminate arbitrariness. Next, in the second step of analysis, a principal component analysis (PCA) will be conducted to examine differences between the output and input factors underlying these institutions' operational efficiency. This will be followed by an examination of the relationship between the factors giving rise to differences in efficiency, from the perspective of different input and output specifications.

The operational efficiency of microfinance institutions will be measured by using DEA in the first step of analysis.[4] The measurement of DEA operates on two different assumptions: that the production frontier exhibits either a constant return to scale (CRS) or a variable return to scale (VRS). The production frontier in this study, with regard to this aspect, was calculated assuming a CRS, following the results of the DEA by Gutiérrez-Nieto et al. (2007). If the production frontier assumes a CRS, the linear programming used in DEA is given by equation (1),

$$
\min_{\lambda,\theta} \theta
$$
$$
s.t. \quad -y_i + Y\lambda \geq 0, \quad \theta x_i - X\lambda \geq 0, \quad \lambda_j \geq 0 \tag{1}
$$

θ_i is a scalar variable representing the technical efficiency of a given microfinance institution i ($\theta_i \leqq 1$), and production occurs on the production frontier when $\theta_i = 1$. X is a vector of input factors, Y is a vector of output factors, y_{ik} and x_{im} represent bank i's output k and input m, respectively. λ represents the constant term vector of $N \times 1$. The bank i's technical efficiency θ_i can be obtained by calculating the production frontier through solving the aforementioned problems with respect to all banks. The value of θ_i

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[4] Compared with a parametric analysis, in a DEA, there is no need to arbitrarily predetermine functional form, and analysis can also be conducted with a relatively small sample without the need to obtain an unbiased estimator (Thanassoulis, 2001). The objectives of microfinance institutions are particularly diverse, and it is difficult to specify the production frontier's functional form in advance. Therefore, DEA offers an advantage because the efficiency of all input and output specifications is calculated, allowing for comparison of the efficiency of different microfinance institutions from a multifaceted perspective.

is unity for the microfinance institution operating efficiently, and the value of θ_i declines as its operations is less efficient.

Theoretically, as DEA does not assume a functional form backed by economic theory, there is need for careful variable selection to avoid meaningless measurement results. [5] In addition, different from ordinal financial institutions, microfinance institutions has an essential role to provide financial services to the poor, therefore considering this point is necessary when specifying input and output factors.

4.2 Examination of management characteristics using PCA

In Step 2, PCA is conducted to examine how the difference in operational efficiency of microfinance institutions measured in Step 1 can be explained by the differences in the input and output specifications. Specifications (combinations of inputs and outputs) are treated as variables and thirty-four microfinance institutions are treated as cases in a PCA. This assessment clarifies what combinations of inputs and outputs would expand the efficiency gap among microfinance institutions[6].

The first principal component Z_1 is obtained by choosing the coefficients a_1, $a_2,\ldots a_n$ such that the unbiased variance $S(Z_1)$, with respect to the variable Z_1 defined in equation (2), is maximum for the efficiency scores calculated for each institution in Step 1 ($X_1, X_2,\ldots, X_n$). The size of vector ($a_1, a_2,\ldots a_n$) is assumed to be unity.

$$Z_1 = a_1 X_1 + a_2 X_2 + \cdots\cdots + a_n X_n \qquad (2)$$

The second principal component Z_2 is obtained by choosing the coefficients b_1, $b_2,\cdots b_n$ such that the unbiased variance $S(Z_2)$, with respect to the variable Z_2 defined in equation (3), is maximum for the efficiency scores of microfinance institutions in the first step of analysis ($X_1, X_2,\ldots, X_n$). The size of vector ($b_1, b_2,\cdots b_n$) is assumed to be unity and uncorrelated with vectors ($a_1, a_2,\ldots a_n$).[7]

$$Z_1 = b_1 X_1 + b_2 X_2 + \cdots\cdots + b_n X_n \qquad (3)$$

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[5] There have been approximately three representative approaches used in past studies involving DEA with respect to production factor and output selection: the value-added, operating, and intermediation approaches (Grigorian and Mahole, 2002).
[6] PCA is a method used to condense multidimensional data to low-dimensional space with minimal loss. By condensing multidimensional data to 2- or 3-dimensional data, the information contained in the data can be visualized.
[7] The lack of correlation between PC1 and PC2 results in a vertical coefficient vector, and an inner product of the coefficient vector of zero.

The third principal component Z_3 was also obtained by following the process similar to the first and the second principal components. In addition, when the sum of the unbiased variance in the efficiency scores of each microfinance institution X_1, X_2,…, X_n is defined as S, the contribution ratio C_i is given by $C_i = S(Z_i)/S$ for the ith principal component, and the cumulative contribution ratio is obtained by calculating the sum of them $C_1 + C_2 + \ldots$.

4.3 Selection of input and output factors and the dataset

According to Yaron (1994), evaluation of microfinance institutions needs double framework of assessment; one is outreach framework for evaluating financial access for the poor the other is sustainability framework for evaluating institution's financial stability and profitability. Following these frameworks, this paper sets evaluation criteria as described in **Table 2**. Microfinance institutions, unlike for-profit financial institutions, such as commercial banks, also carry the role of expanding access to financial services for the poor. Microfinance institutions also strive to maintain the sustainability of operations, and the expansion of its scale, by earning income appropriately and utilizing financial resources for their own operations, in contrast with pure aid organizations and philanthropic groups. However, profit seeking can be a means to increase outreach activities, and this is not necessarily purposeful.

Table 2. Assessment Framework for Operational Characteristics of MFIs

As described in **Table 3**, three outputs and two inputs are assumed in this study, in the same manner as in Gutiérrez-Nieto et al. (2007). Output 1 and output 2 are the variables representing the degree of outreach conducted by microfinance institutions. The number of borrowers and outstanding amount of loans were used as proxy variables for output 1 and output 2, respectively. Output 3 is the variable representing the degree of sustainability practiced by microfinance institutions. Interest income, the most important source of income of microfinance institutions, was used as a proxy variable for output 3.[8] Input A is the amount of labor input, and the number of employees was used as a proxy variable for it. Input B is input factor other than labor input, and total operating expenses are used as the proxy variable for it. The dataset used in this study was created from the annual report published by the NBC (NBC 2008; 2011; 2014). The 2013 microfinance institution dataset is provided in **Table 4.**

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[8] Refer to Okuda et al. (2014) for more information concerning the management characteristics of microfinance institutions.

Table 3. Inputs and Outputs included in DEA Efficiency
Table 4. Microfinance Institution Dataset

5. Measurement Results
5.1 DEA efficiencies

The operational efficiency of each microfinance institution calculated by using DEA under the assumption of constant return to scale are shown in **Table 5**. Different combinations of inputs and outputs generate different views of the way in which a microfinance institution operates. The efficiency results of each institution depend on the combination of input and output specifications and therefore the efficiency results for sustainability-oriented specifications differ from those for outreach-oriented specifications.

Table 5. MFIs Efficiency Results under the 21 Specifications

For instance, PRASAC, the microfinance institution with the largest-scale operations, had an efficiency score of 1 when the number of employees and operational expenses were selected as input factors and interest income was selected as sustainability-oriented output factor, e.g., AB2. This input/output specification is sustainability-oriented and, when viewed from the perspective of operational sustainability, the operational efficiency of PRASAC was demonstrated to be the most efficient across all institutions evaluated. However, when the number of borrowers was selected as the outreach-oriented output factor, the operational efficiency score of PRASAC decreased to 0.3 where the output factor was number of employees (e.g., A1), and to 0.24 where the output factor was operating expenses, respectively(e.g., B1). Based upon the above findings, although PRASAC exhibited high operational efficiency under a sustainability framework focusing on the profitability of operation, it operates less efficiently under an outreach framework geared towards expanding access to the poor.

5.2 Estimation results of principal component analysis

PCA was conducted in Step 2 for extracting the comprehensive information to understand the operational characteristics of Cambodian micro-finance institutions from the data on efficiency results obtained in Step 1. Factor loadings by PCA, regarding the

efficiency results in **Table 5**, are given in **Table 6**.[9] Factor loadings describe the correlation coefficients between each principal component, PC1, PC2, or PC3, and 21 input/output specifications; they represent the magnitude of contribution of specifications to principal components. When contribution of specifications to principal components was large, factor loadings were closer to 1 or -1. PC1 accounted for 71% of the variance, PC2 accounted further 13% of the variance with a cumulative contribution ratio of 84%, and PC3 accounted for 9 % of the variance with a cumulative ratio of 93%. In general, a description of 80% or more of the data available is considered sufficient in instances in which the dimension of principal component analytical data is condensed.

Table 6. Component Loading Matrix

When we look at PC1, the factor loadings for all input/output specifications were close to -1, and all specifications demonstrated a strong contribution to PC1. Specifications containing many inputs/outputs, such as AB123, demonstrated a greater factor loading absolute value than specification containing fewer input/outputs, such as A1. These observations explain PC1 implies the overall efficiency of each microfinance institution in both sustainability and outreach. The overall efficiency of microfinance institution increases as an institution's score under PC1 decreases, or approaches -1.

When we look at PC2, the factor loadings of outreach-oriented specifications that set the number of borrowers as the output factor were the closest to -1. A1, B1, and AB1 were found to produce the strongest contribution to PC2. In addition, for sustainability-oriented specifications with interest income as the output factor, all factor loadings were positive, as with A2, B2, and AB2, and were close to 1. These three input/output specifications were found to produce a strong contribution to PC2. Therefore, as an microfinance institution's score increases under PC2, the institution's orientation towards sustainability becomes more pronounced In contrast, as an institution's score decreases under PC2, the institution's orientation toward outreach becomes more pronounced (as factor loadings for A1, B1, and AB1 were close to -1).

When we look at PC3, comparing the specifications with number of employees as the input factor, such as in A1, A12 through A123, and so on, against the specifications

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[9] Regarding the results of the PCA conducted in this study, there is a possibility in using PCA that the eigenvalues and eigenvectors, with respect to the positive or negative signs for the principal components and principal component scores, may become reversed when the algorithm to obtain them changes. Specifically, when depicting a scatterplot regarding an individual entity, the high, low, left, and right results will become reversed when the associated algorithm differs. PCA is among the variables, rather than an absolute relationship between individual entities; there are no analytical problems because of this relative relationship. Results obtained using the R programming language are calculated from the precomp function.

with operational expenses as the input factor, such as B1, B12 through B123, and so on, the former specification group was all negative, while the latter specifications group was all positive. Essentially, PC3 implies that microfinance institutions fall into two groups self-selecting a management strategy, and they will seek to be efficient in terms of either number of employees (the amount of output per employee is high), or operational costs (the amount of output per operational costs is high).

5.3 Observations

Figure 1 plots a plot of the microfinance institutions' scores under PC1 and PC2. The horizontal axis represents each institution's score under PC1; overall efficiency increases as an institution's score moves to the left on the plot. The vertical axis represents institutions' scores under PC2; an institution's orientation towards outreach increases as its score moves downward on the plot, and its orientation towards sustainability increases as its score moves upward. The origin of the plot (0,0) represents the mean score; points plotted to the left or right of the mean, or above or below, represent scores above, or below, the mean.

Figure 1. Distribution Plot for PC1 and PC2

The plot displayed in **Figure 1** is divided into four quadrants at the origin (0,0); microfinance institutions with scores falling within the second quadrant exhibit high overall efficiency, as well as a strong orientation toward sustainability. Microfinance institutions with scores falling within the third quadrant exhibit high overall efficiency and a strong outreach orientation. Microfinance institutions with scores falling within the first quadrant exhibit low overall efficiency and a strong sustainability orientation. Microfinance institutions with scores falling within the fourth quadrant exhibit low overall efficiency and a strong outreach orientation. Out of the thirty-four Cambodian microfinance institutions displayed in **Figure 1**, those surrounded with a black framing are large-scale institutions, while those surrounded with a red framing are small-scale institutions.

Observations derived from **Figure 1** regarding the management characteristics of microfinance institutions are described in the following. First, out of the thirty-four microfinance institutions observed, twelve institutions, or approximately one-third of the total, were outreach-oriented, i.e., obtained a negative score under PC2, while the remaining institutions were sustainability-oriented, i.e., obtaining a positive score under PC2. The majority of Cambodian microfinance institutions emphasize sustainability of

operations, while、 in terms of expanding financial access to the poor, their efficiency is not high.

Second, all eight large-scale microfinance institutions exhibited above-average efficiency regarding PC1 which described overall efficiency; large-scale microfinance institutions obtained negative scores under PC1. However, in contrast, the majority of small-scale microfinance institutions exhibited below-average efficiency under PC1; eleven out of fifteen small-scale microfinance institutions obtained positive scores under PC1. In addition, many of the large-scale microfinance institutions were foreign institutions, and it maight suggest that the management skills employed by these institutions were superior to those used by local institutions.

Third, out of the thirty-four microfinance institutions observed, only six institutions exhibited high overall efficiency and were also outreach-oriented, i.e., these microfinance institutions falled within the second quadrant, comprising one-fifth of the sample. Five institutions out of these six microfinance institutions were foreign institutions.

Figure 2 shows each institution's score under PC1 and PC3. As in **Figure 1**, the horizontal-axis of **Figure 2** describes overall efficiency, which increases as points shift to the left. The vertical-axis describes whether institutions adopt a management strategy with staff count efficiency or cost-effective operational spending. As an institution's score fell lower on the plot, cost-effective operational spending (i.e., saving the operational costs and using the number of employees more intensively was selected) as a management strategy. Likewise, as an institution's score fell higher on the plot, staff count efficiency (i.e., saving the number of employees and spending the operational costs more intensively was selected) as a management strategy.

Figure 2. Distribution Plot for PC1 and PC3

Figure 2, as in **Figure 1**, is divided into four quadrants at the origin (0, 0); microfinance institutions with scores falling within the second quadrant exhibit high overall efficiency, and staff count efficiently as a management strategy, or saving the number of employees. Microfinance institutions with scores falling within the third quadrant exhibit high overall efficiency, and cost-effective operational spending as a management strategy, or saving the operational costs. Microfinance institutions with scores falling within the first quadrant exhibit low overall efficiency, and staff count efficiently as a management strategy. Microfinance institutions with scores falling within the fourth quadrant exhibit low overall efficiency, and selected cost-effective

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operational spending as a management strategy. Microfinance institutions within a black framing are large-scale institutions, while those within the red framing are small-scale institutions.

Observations gleaned from Figure 2 regarding microfinance institutions' management characteristics are described in the following. First, although there were ten small-scale domestic microfinance institutions assessed, nine of these institutions selected staff count efficiency as the management strategy. Over half of the twenty foreign institutions assessed, in contrast, selected cost-effective operational spending as the management strategy.

Second, there is no clear relationship between size of institutions and selection of management strategy. A total of fifteen institutions, five large-scale and ten small-scale institutions, selected staff count efficiency as the management strategy. Contrastively, out of the eleven medium-scale microfinance institutions assessed, eight selected cost-effective operational spending as the management strategy.

Third, there is no clear relationship between overall efficiency and management strategy. Out of the sixteen institutions that exhibited high overall efficiency, ten institutions selected staff count efficiency as the management strategy. However, the remaining six institutions selected cost-effective operational spending as the management strategy. Furthermore, of the eighteen microfinance institutions exhibiting low overall efficiency, ten selected cost-effective operational spending as the management strategy. However, the remaining eight institutions selected staff count efficiency as the management strategy.

The results described above were nearly identical to those obtained during two similar analyses using data from 2010 (**Table A1** and **Figure A1**, and **Figure A2** in Appendix) and data from 2007 (**Table A1**, **Figure A3**, and **Figure A4** in Appendix). Each of these results demonstrated, similar to the result using data from 2013, that PC1 shows the overall efficiency of each microfinance institution in both sustainability and outreach; PC2 shows which efficiency was high in regard to outreach or sustainability; and that PC3 shows which were used more efficiently in regard to the size of employees or the amount of operational costs. In addition, high overall operational efficiency in large-scale microfinance institutions, relatively less common instances of high efficiency outreach-oriented institutions, diversity of management strategy regarding employee size and operations spending, and generally high efficiency in foreign microfinance institutions were observed.

6. Conclusion

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This study analyzed the management characteristics of thirty-four major Cambodian microfinance institutions, using a 2013 microfinance institution data set. The analysis was conducted in two steps: in Step 1, a multifaceted assessment of microfinance institutions' operational efficiency was conducted, using the DEA to consider two management objectives: operational sustainability and poverty reduction. Next, in Step 2, a principal component analysis was conducted using the efficiency scores measured in the first step of analysis, and the distinctions between each microfinance institution's operational structures were categorized.

Based on this analysis, (1) large-scale microfinance institutions exhibited higher overall efficiency, (2) approximately two-third of microfinance institutions were focused on sustainability and remaining one-third were focused on outreach, and (3) less than one-fifth of microfinance institutions exhibited both high overall efficiency and also focused on outreach as a management characteristic. In addition, (4) foreign microfinance institutions exhibit comparatively higher overall efficiency, and (5) small-scale and local microfinance institutions use employees efficiently, e.g., saving the number of employees.

Comparing the results of this study to those obtained by Gutiérrez-Nieto et al. (2007) analyzing Latin American countries, the results of the principal component analyses were largely similar. Specifically, in either analysis, PC1 described the overall efficiency of microfinance institutions, PC2 described whether the institutions exhibited a tendency toward emphasis on outreach or sustainability, and PC3 described whether institutions selected a management strategy that was efficient regarding the number of employees or operational costs. However, differences in each principal component's degree of contribution were observed. In the analysis of this study, PC2 and PC3 had a lower degree of contribution than in Gutiérrez-Nieto et al. (2007). This study, which used its sample set containing only Cambodian non-NGO financial institutions, differs from the Gutiérrez-Nieto et al. (2007), which used its sample set including both non-NGO and NGO-managed microfinance institutions in multiple Latin American countries. Therefore, large differences are observed to exist in the management objectives of the microfinance institutions in Gutiérrez-Nieto et al. (2007).

The obtained results of this study have three policy implications concerning development of the Cambodian microfinance sector. First, as large-scale microfinance institutions exhibited higher overall efficiency, expanding the scale of operations is required to improve operational efficiency. Considering this point, it can be said that efforts by the Cambodian government to expand the scale of microfinance institutions, are reasonable from a development perspective of the nation's financial sector.

Second, on the other hand, large-scale microfinance institutions are likely to lose operational efficiency from the view point of outreach framework, i.e., focusing on expansion of financial service access for the poor. Therefore, accounting for the provision of financial services for the poor, while expanding the scale of operations, is particularly necessary regarding Cambodian government's policy promoting the expansion of microfinance institution operations.

Third, according to the results of this paper's analysis, majority of Cambodian microfinance institutions emphasize sustainability instead of outreach. The fact that several microfinance institutions were eventually conversed to commercial banks seems to confirm that their management strategies were oriented strongly toward sustainability. This observation suggests that the Cambodian government must construct policy that increases access to microfinance institutions for the poor, and it is necessary to cultivate an environment where more people can take advantage of microfinance.

Lastly, this study has the limitations and the remaining research topics to investigate in the future. The analytical method presented in this paper was based on Gutiérrez-Nieto et al. (2007), and operational efficiency of microfinance institutions was measured by using DEA under the assumption of CRS. However, the assumption of a VRS was generally valid in cases in which the amount of input factors could not be sufficiently adjusted for short time periods. Future necessary tasks include conducting DEA and PCA using the same data sample under the assumption of a VRS, and confirming how the analytical results of this study may change.

As this study focused solely on Cambodian case of microfinance, its analytical results can describe a relative assessment of Cambodian microfinance institutions. However, a international comparative assessment of microfinance institutions is necessary to clarify further the characteristics of Cambodian microfinance institutions. Since microfinance institutions' activities among ASEAN countries have a long history and comparative operational characteristics of Cambodian microfinance institutions following a comparison against an international data set.

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Table 1. Operating Indices of Microfinance Institutions

	Number of Villages	Number of offices	Foreign ownership	Total assets	Number of borrowers	Interest income	Loans	Nmuber of employees	Operational expenses
PRASAC	12107	173	89%	1806503	196906	273096	1514398	2765	92123
AMRET	9758	87	98%	1003067	309458	198389	814112	1444	99318
SATHAPANA	8618	111	73%	832901	78862	131634	725451	2147	62792
HATTHAKAKSEKAR	8832	136	76%	717629	83416	119013	581942	1614	59821
AMK	11358	128	98%	406031	324499	97777	316839	2911	51469
TPC	7372	46	92%	379695	153952	76236	299411	874	30937
CREDIT	5402	66	100%	350287	73115	64672	296435	994	32733
VFC	6317	92	100%	291934	191974	63728	246102	967	34685
ACTIVE PEOPLE	75	3	100%	78319	11532	8566	53012	106	2602
LY HOUR	798	7	49%	57368	2583	4099	49657	170	3386
AEON	1354	1	100%	55836	18484	9066	43599	190	6061
FIRST FINANCE	266	3	85%	43276	1901	5416	36284	35	2693
SAMIC	1344	17	75%	41903	17015	11099	34991	193	5867
IPR	489	11	34%	32574	4199	8215	26533	101	3147
CHAMROEUN[1]	3620	40	89%	31042	52419	9800	25295	333	8647
GCMF	484	4	100%	30535	3289	5915	26713	102	3962
SONATRA	271	5	30%	27022	271	3751	21608	68	2267
MALIS	350	3	100%	24316	3043	4404	21259	79	2776
SEILANITHIH	1428	25	40%	23082	8480	7270	19115	191	5799
SAMRITHISAK	191	1	0%	18602	442	2590	16431	63	1601
EAP	85	1	0%	17676	196	1717	12485	18	765
CAMMA	197	1	0%	17219	792	2561	14242	32	993
MAXIMA	452	7	0%	14047	3195	3176	12581	80	1929
PRIME	226	2	100%	12305	816	1787	10949	51	1474
CBIRD	488	9	61%	11649	5574	3264	10845	82	1828
KHEMARAK	96	2	0%	9802	260	1425	4771	24	544
CITY	48	1	80%	8006	146	479	3449	13	496
FUDF	27	1	33%	7736	902	564	6494	8	215
YCP	179	3	0%	4230	580	778	3757	41	601
ANGKOR ACE	85	1	0%	3682	121	281	923	12	471
BAYON	173	4	0%	3165	604	807	2482	22	427
BORIBO	34	3	0%	2438	52	411	2249	12	280
KEY	186	2	0%	2209	695	389	1572	23	457
FARMER FINANCE	1	1	100%	1582	306	1419	9	215	0

(Source) NBC, Annual Report 2014
(Notes) All values were as of the end of 2013. Income and expenses were measured in million KHR.

Table 2. Assessment Framework for Operational Characteristics of MFIs

Outreach framework	Sustainability framework
Number of borrowers (output) Amount of loans (output)	Interest income (output) Operating expenses (input) Number of employees (input)

Table 3. Inputs and Outputs included in DEA Efficiency

Ouptuts	Inputs
Output 1. Number of borrowers Output 2. Outstanding amount of loans Output 3. Interest income (million KHR)	Input A. Operating expenses (million KHR) Input B. Number of employees

Table 4. Microfinance Institutions Dataset

	Number of employees	Operating expenses	Number of borrowers	Interest income	Loans
PRASAC	2765	92123	196906	273096	1514398
AMRET	1444	99318	309458	198389	814112
SATHAPANA	2147	62792	78862	131634	725451
HATTHAKAKSEKAR	1614	59821	83416	119013	581942
AMK	2911	51469	324499	97777	316839
TPC	874	30937	153952	76236	299411
CREDIT	994	32733	73115	64672	296435
VFC	967	34685	191974	63728	246102
ACTIVE PEOPLE	106	2602	11532	8566	53012
LY HOUR	170	3386	2583	4099	49657
AEON	190	6061	18484	9066	43599
FIRST FINANCE	35	2693	1901	5416	36284
SAMIC	193	5867	17015	11099	34991
IPR	101	3147	4199	8215	26533
CHAMROEUN[1]	333	8647	52419	9800	25295
GCMF	102	3962	3289	5915	26713
SONATRA	68	2267	271	3751	21608
MALIS	79	2776	3043	4404	21259
SEILANITHIH	191	5799	8480	7270	19115
SAMRITHISAK	63	1601	442	2590	16431
EAP	18	765	196	1717	12485
CAMMA	32	993	792	2561	14242
MAXIMA	80	1929	3195	3176	12581
PRIME	51	1474	816	1787	10949
CBIRD	82	1828	5574	3264	10845
KHEMARAK	24	544	260	1425	4771
CITY	13	496	146	479	3449
FUDF	8	215	902	564	6494
YCP	41	601	580	778	3757
ANGKOR ACE	12	471	121	281	923
BAYON	22	427	604	807	2482
BORIBO	12	280	52	411	2249
KEY	23	457	695	389	1572
FARMER FINANCE	215	0	306	1419	9

(Source) NBC, Annual Report 2014.
(Notes) All values were as of the end of 2013. Income and expenses were measured in million KHR.

Table 5. MFIs Efficiency Results under the 21 Specifications

	A1	A12	A123	A13	A2	A23	A3	AB1	AB12	AB123	AB13
PRASAC	0.30	0.67	0.67	0.59	0.64	0.64	0.53	0.30	1.00	1.00	0.65
AMRET	0.90	1.00	1.00	0.90	0.89	0.89	0.54	0.90	1.00	1.00	0.90
SATHAPANA	0.16	0.41	0.41	0.35	0.40	0.40	0.33	0.16	0.68	0.68	0.41
HATTHAKAKSEKAR	0.22	0.50	0.50	0.39	0.48	0.48	0.35	0.22	0.71	0.71	0.42
AMK	0.47	0.47	0.47	0.47	0.22	0.22	0.11	0.71	0.72	0.72	0.71
TPC	0.74	0.79	0.79	0.74	0.56	0.56	0.33	0.74	0.97	0.97	0.74
CREDIT	0.31	0.46	0.46	0.35	0.42	0.42	0.29	0.31	0.69	0.69	0.36
VFC	0.84	0.85	0.85	0.84	0.43	0.43	0.25	0.84	0.85	0.85	0.84
ACTIVE PEOPLE	0.46	0.58	0.65	0.58	0.52	0.52	0.48	0.50	1.00	1.00	0.68
LY HOUR	0.06	0.16	0.29	0.29	0.16	0.28	0.28	0.09	0.37	0.49	0.49
AEON	0.41	0.43	0.43	0.41	0.31	0.31	0.22	0.41	0.56	0.56	0.41
FIRST FINANCE	0.11	1.00	1.00	1.00	1.00	1.00	1.00	0.11	1.00	1.00	1.00
SAMIC	0.37	0.42	0.42	0.37	0.37	0.37	0.18	0.37	0.66	0.66	0.37
IPR	0.18	0.54	0.54	0.29	0.53	0.53	0.25	0.18	0.86	0.86	0.32
CHAMROEUN[1]	0.66	0.66	0.66	0.66	0.19	0.19	0.07	0.69	0.69	0.69	0.69
GCMF	0.14	0.39	0.39	0.28	0.38	0.38	0.25	0.14	0.55	0.55	0.30
SONATRA	0.02	0.36	0.36	0.31	0.36	0.36	0.31	0.02	0.56	0.56	0.38
MALIS	0.16	0.38	0.38	0.29	0.36	0.36	0.26	0.16	0.55	0.55	0.32
SEILANITHIH	0.19	0.27	0.27	0.19	0.25	0.25	0.10	0.19	0.42	0.42	0.19
SAMRITHISAK	0.03	0.27	0.27	0.25	0.27	0.27	0.25	0.03	0.50	0.50	0.34
EAP	0.05	0.62	0.67	0.67	0.62	0.67	0.67	0.05	0.86	0.92	0.79
CAMMA	0.10	0.52	0.52	0.44	0.52	0.52	0.43	0.10	0.85	0.85	0.54
MAXIMA	0.17	0.28	0.28	0.19	0.26	0.26	0.15	0.19	0.50	0.50	0.22
PRIME	0.07	0.23	0.23	0.22	0.23	0.23	0.21	0.07	0.39	0.40	0.26
CBIRD	0.29	0.31	0.31	0.29	0.26	0.26	0.13	0.35	0.57	0.57	0.35
KHEMARAK	0.05	0.38	0.38	0.20	0.38	0.38	0.19	0.05	0.80	0.80	0.29
CITY	0.05	0.24	0.26	0.26	0.24	0.26	0.26	0.05	0.35	0.37	0.31
FUDF	1.00	1.00	1.00	1.00	0.46	0.78	0.78	1.00	1.00	1.00	1.00
YCP	0.06	0.13	0.13	0.10	0.12	0.12	0.09	0.11	0.39	0.39	0.21
ANGKOR ACE	0.04	0.16	0.16	0.08	0.15	0.15	0.07	0.04	0.22	0.22	0.09
BAYON	0.12	0.25	0.25	0.13	0.24	0.24	0.11	0.16	0.57	0.57	0.19
BORIBO	0.02	0.22	0.22	0.18	0.22	0.22	0.18	0.02	0.45	0.45	0.27
KEY	0.13	0.14	0.14	0.13	0.11	0.11	0.07	0.17	0.27	0.27	0.17
FARMER FINANCE	0.14	0.24	0.24	0.18	0.22	0.22	0.15	0.16	0.43	0.43	0.22

Table 5. MFIs Efficiency Results under the 21 Specifications

	AB2	AB23	AB3	B1	B12	B123	B13	B2	B23	B3
PRASAC	1.00	1.00	0.65	0.24	0.90	0.90	0.54	0.90	0.90	0.54
AMRET	0.95	0.95	0.56	0.35	0.62	0.62	0.35	0.61	0.61	0.27
SATHAPANA	0.68	0.68	0.41	0.14	0.64	0.64	0.38	0.64	0.64	0.38
HATTHAKAKSEKAR	0.71	0.71	0.42	0.16	0.60	0.60	0.32	0.60	0.60	0.32
AMK	0.58	0.58	0.20	0.71	0.72	0.72	0.71	0.58	0.58	0.20
TPC	0.86	0.86	0.40	0.56	0.81	0.81	0.56	0.75	0.75	0.32
CREDIT	0.66	0.66	0.36	0.25	0.60	0.60	0.30	0.60	0.60	0.30
VFC	0.65	0.65	0.30	0.63	0.68	0.68	0.63	0.56	0.56	0.24
ACTIVE PEOPLE	1.00	1.00	0.68	0.50	1.00	1.00	0.68	1.00	1.00	0.68
LY HOUR	0.37	0.49	0.49	0.09	0.37	0.49	0.49	0.37	0.49	0.49
AEON	0.50	0.50	0.28	0.35	0.49	0.49	0.35	0.45	0.45	0.24
FIRST FINANCE	1.00	1.00	1.00	0.04	0.61	0.63	0.45	0.61	0.63	0.45
SAMIC	0.62	0.62	0.22	0.33	0.59	0.59	0.33	0.58	0.58	0.20
IPR	0.86	0.86	0.32	0.15	0.79	0.79	0.28	0.79	0.79	0.28
CHAMROEUN[1]	0.35	0.35	0.10	0.69	0.69	0.69	0.69	0.34	0.34	0.10
GCMF	0.55	0.55	0.30	0.09	0.45	0.45	0.22	0.45	0.45	0.22
SONATRA	0.56	0.56	0.38	0.01	0.50	0.50	0.32	0.50	0.50	0.32
MALIS	0.55	0.55	0.32	0.12	0.48	0.48	0.25	0.48	0.48	0.25
SEILANITHIH	0.41	0.41	0.12	0.17	0.38	0.38	0.17	0.38	0.38	0.11
SAMRITHISAK	0.50	0.50	0.34	0.03	0.49	0.50	0.34	0.49	0.50	0.34
EAP	0.86	0.92	0.79	0.03	0.68	0.72	0.54	0.68	0.72	0.54
CAMMA	0.85	0.85	0.54	0.09	0.78	0.78	0.48	0.78	0.78	0.48
MAXIMA	0.50	0.50	0.22	0.19	0.50	0.50	0.22	0.50	0.50	0.22
PRIME	0.39	0.40	0.26	0.06	0.37	0.37	0.25	0.37	0.37	0.25
CBIRD	0.54	0.54	0.20	0.35	0.57	0.57	0.35	0.54	0.54	0.20
KHEMARAK	0.80	0.80	0.29	0.05	0.80	0.80	0.29	0.80	0.80	0.29
CITY	0.35	0.37	0.31	0.03	0.29	0.31	0.23	0.29	0.31	0.23
FUDF	0.82	1.00	1.00	1.00	1.00	1.00	1.00	0.80	1.00	1.00
YCP	0.39	0.39	0.21	0.11	0.39	0.39	0.21	0.39	0.39	0.21
ANGKOR ACE	0.22	0.22	0.09	0.03	0.18	0.18	0.07	0.18	0.18	0.07
BAYON	0.57	0.57	0.19	0.16	0.57	0.57	0.19	0.57	0.57	0.19
BORIBO	0.45	0.45	0.27	0.02	0.45	0.45	0.27	0.45	0.45	0.27
KEY	0.26	0.26	0.11	0.17	0.27	0.27	0.17	0.26	0.26	0.11
FARMER FINANCE	0.43	0.43	0.22	0.16	0.43	0.43	0.22	0.43	0.43	0.22

Table 6. Component Loading Matrix

Specifications: Combinations of Inputs and Outputs	PC1	PC2	PC3
A1	-0.644	-0.715	-0.080
A12	-0.922	-0.167	-0.290
A123	-0.936	-0.153	-0.285
A13	-0.896	-0.226	-0.362
A2	-0.815	0.359	-0.336
A23	-0.884	0.292	-0.324
A3	-0.805	0.385	-0.365
AB1	-0.616	-0.757	-0.036
AB12	-0.969	0.045	0.09
AB123	-0.975	0.062	0.078
AB13	-0.896	-0.207	-0.285
AB2	-0.903	0.333	0.114
AB23	-0.936	0.307	0.103
AB3	-0.817	0.371	-0.219
B1	-0.545	-0.799	0.158
B12	-0.882	-0.048	0.448
B123	-0.891	-0.028	0.434
B13	-0.784	-0.395	0.133
B2	-0.825	0.256	0.479
B23	-0.861	0.220	0.442
B3	-0.740	0.230	0.148
contribution ratio	0.71	0.13	0.09
cumulative contribution ratio	0.71	0.84	0.93

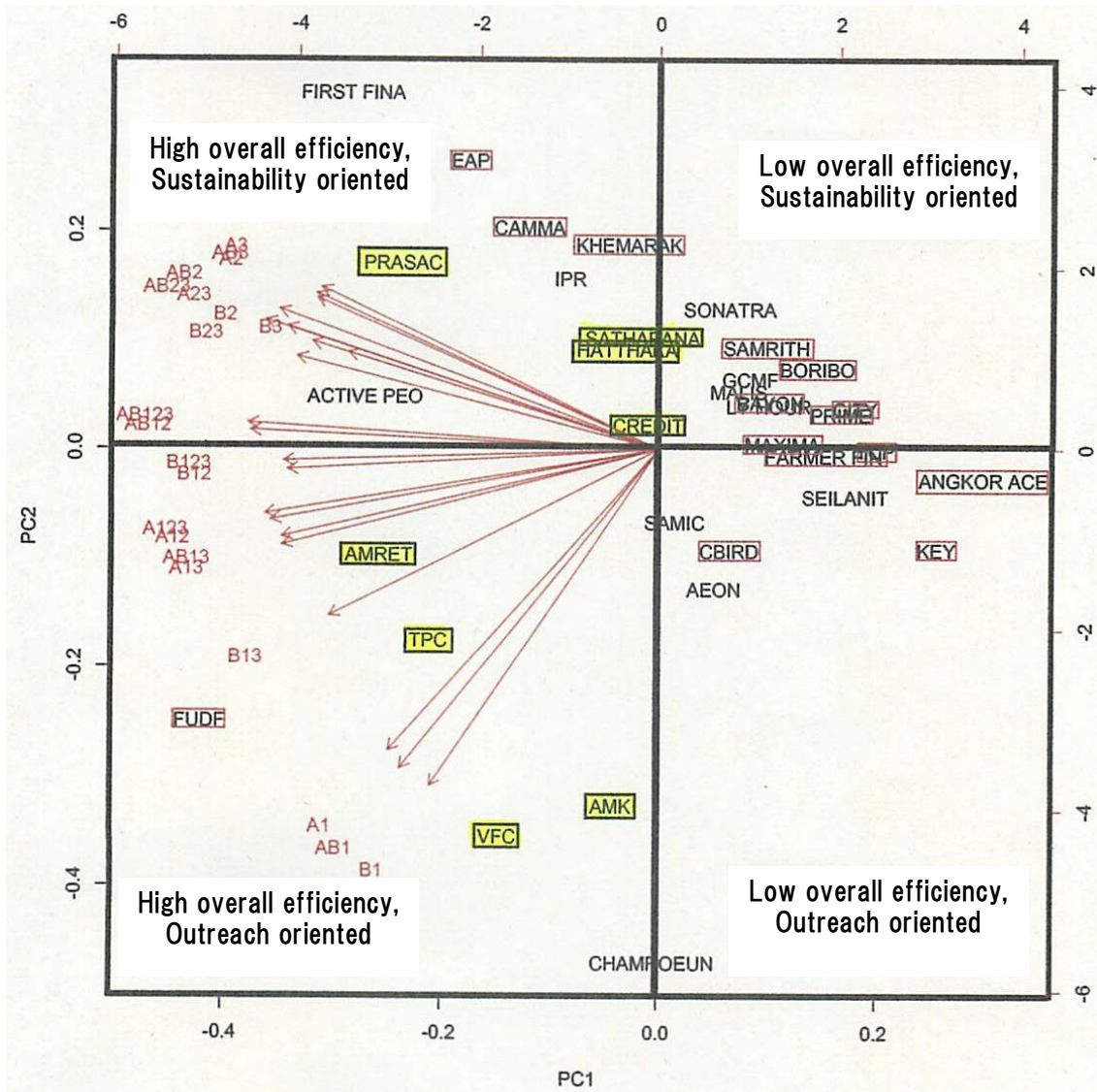**Figure 1. Distribution Plot for PC1 and PC2**
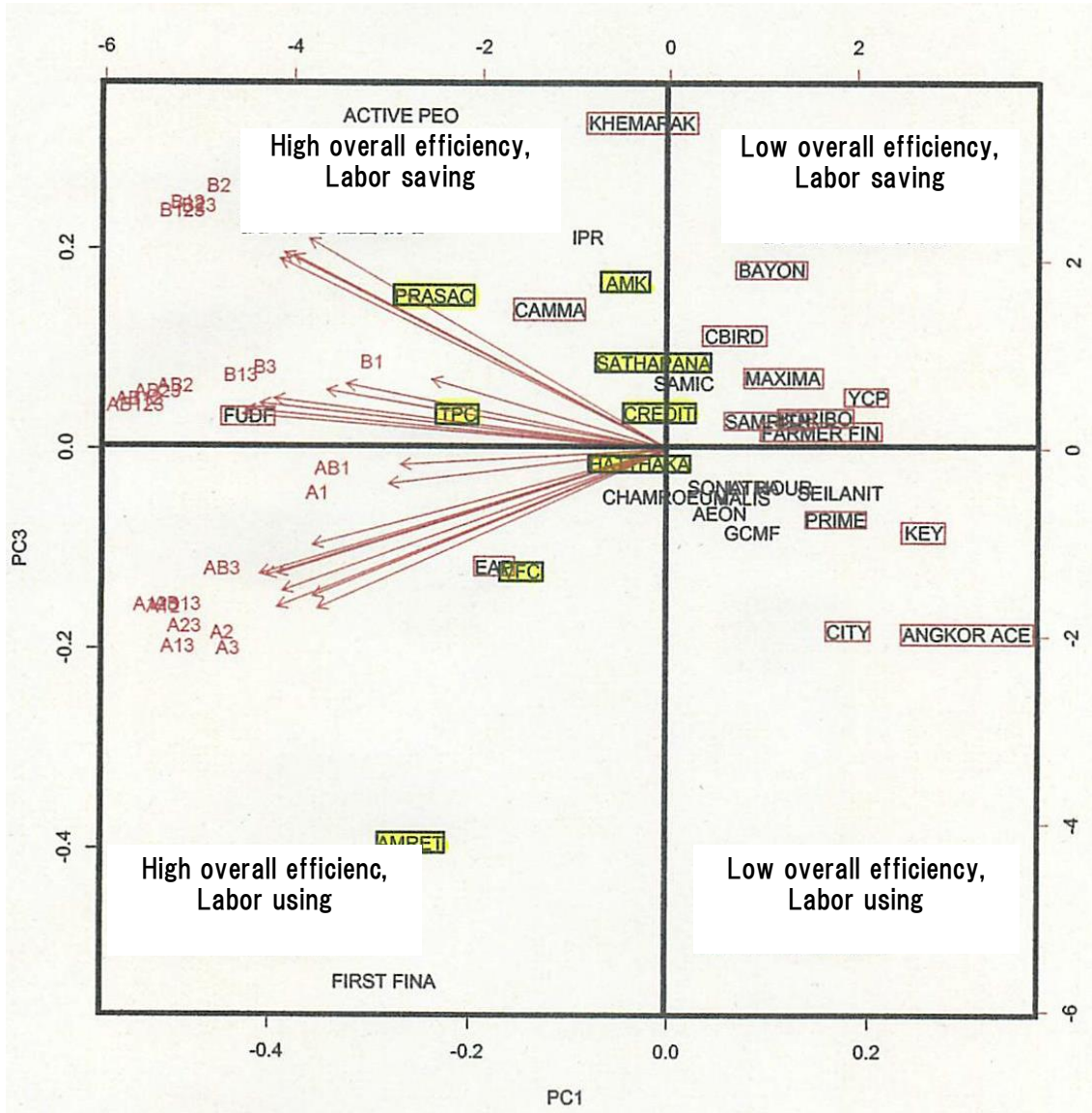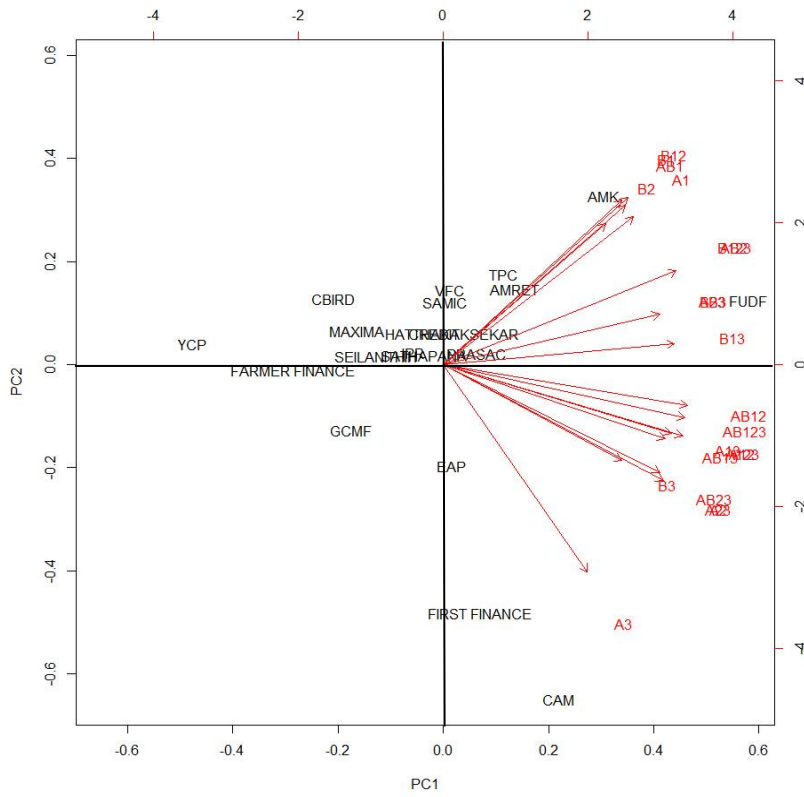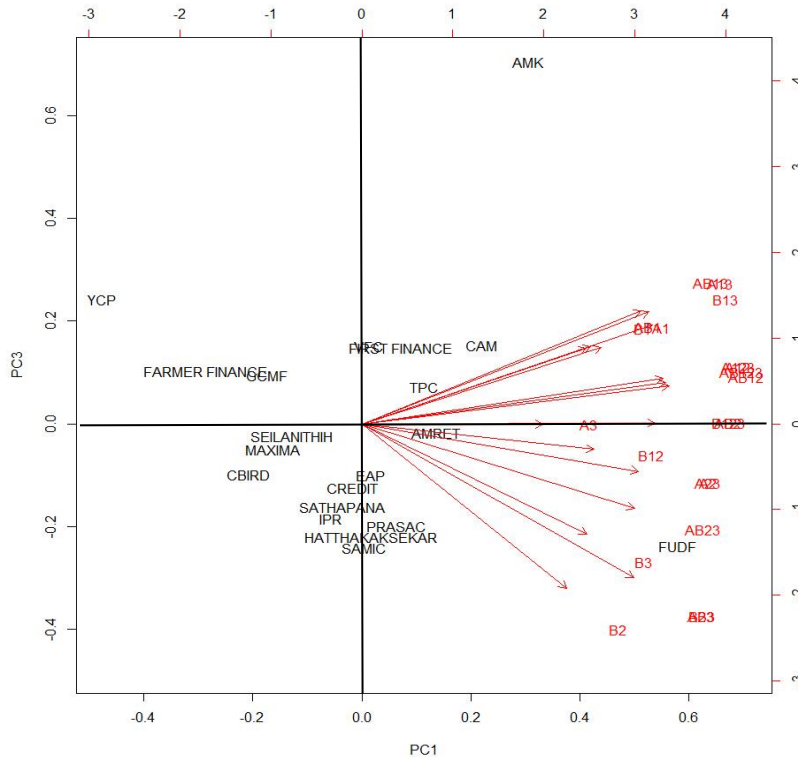
Figure 2. Distribution Plot for PC1 and PC3

Appendix

<div align="center">

Table A1. Component Loading Matrix

| Specifications: Combinations of Inputs and Outputs	2010			2007		
	PC1	PC2	PC3	PC1	PC2	PC3
A1	0.736	0.582	0.250	0.553	-0.677	-0.336
A12	0.926	-0.281	0.147	0.735	-0.201	-0.492
A123	0.926	-0.281	0.147	0.799	-0.090	-0.552
A13	0.881	-0.272	0.366	0.840	-0.271	-0.438
A2	0.850	-0.458	-0.155	0.659	0.572	-0.271
A23	0.850	-0.458	-0.155	0.711	0.594	-0.324
A3	0.557	-0.816	-0.001	0.839	0.355	-0.308
AB1	0.703	0.629	0.253	0.550	-0.756	0.158
AB12	0.944	-0.162	0.123	0.845	-0.317	0.306
AB123	0.934	-0.209	0.136	0.926	-0.237	0.197
AB13	0.857	-0.292	0.368	0.907	-0.316	0.048
AB2	0.900	0.369	0.003	0.715	0.542	0.336
AB23	0.837	-0.425	-0.276	0.762	0.576	0.234
AB3	0.835	0.199	-0.502	0.870	0.361	-0.162
B1	0.689	0.648	0.247	0.485	-0.816	0.217
B12	0.712	0.660	-0.083	0.803	-0.393	0.376
B123	0.900	0.369	0.003	0.907	-0.289	0.243
B13	0.893	0.083	0.323	0.889	-0.335	0.077
B2	0.628	0.555	-0.535	0.664	0.498	0.515
B23	0.835	0.199	-0.502	0.731	0.556	0.349
B3	0.691	-0.379	-0.359	0.863	0.355	-0.137
contribution ratio	0.674	0.193	0.080	0.599	0.222	0.102
cumulative contribution ratio	0.674	0.867	0.947	0.599	0.822	0.924

</div>

Figure A1. Distribution Plot for PC1 and PC2 (2010)

Figure A2. Distribution Plot for PC1 and PC3 (2010)

Figure A3. Distribution Plot for PC1 and PC2 (2007)
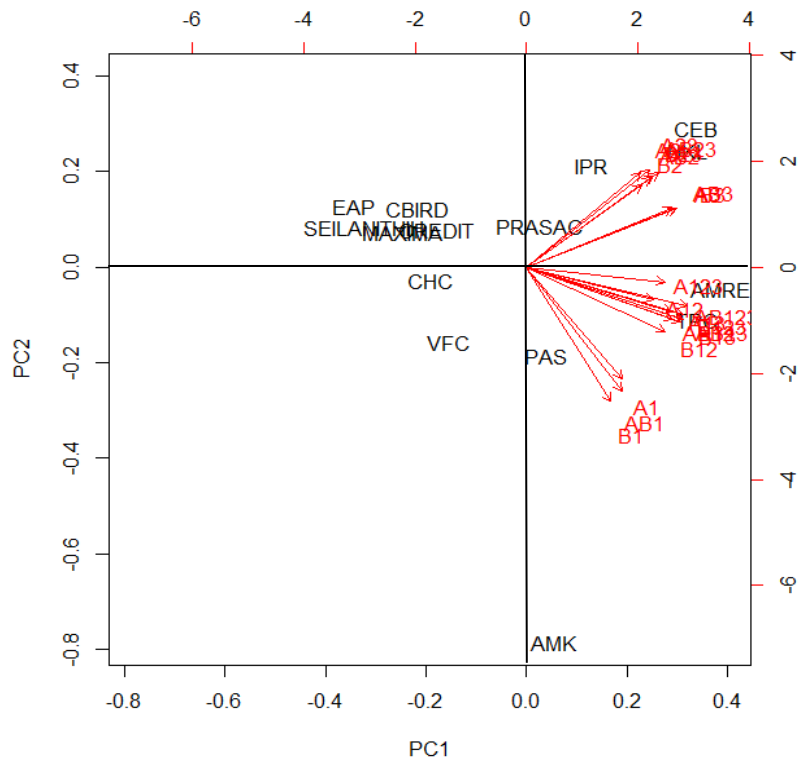
Figure A4. Distribution Plot for PC1 and PC3 (2007)