CHAPTER 5

# RESEARCH METHODOLOGY

This chapter presents the research methodology that is adopted throughout this study. This includes the discussions on sample selection, data analysis techniques, input and output specifications and sources of data.

## 5.1 SAMPLE SELECTION

The sample for this study covers all the five mobile operators in Malaysia, which are Celcom, Digi, Maxis, TM Cellular and TimeCel. However, only mobile services that operate using digital network platform are considered for this study. Hence, Celcom and TM Cellular analogue services under the brand name of ATUR 900 and Mobikom 018 are not taken into consideration[10]. There are several reasons for selecting digital network over analogue network platform:

1. Growing numbers of subscribers have moved to use the more advanced, digital network platform that offers more value-added services[11].

[10] Celcom remains offering the analog technology side by side with the digital technology. On the other hand, all Mobikom 018 subscribers have successfully been transferred to the TM Touch digital network on October 28, 2002.
[11] As at 3rd quarter of 2002, digital mobile subscribers accounted for 96 percent of total mobile subscribers.

2. Analogue network platform is not available to some of the operators; hence, it is more reliable to compare the productivity and efficiency of the operators with the data that they all have in common; the digital network platform.

Digital network services started to operate in mid-1995, with each operator offering the services at different period within the year. Thus, to avoid data inconsistency; this study starts from year 1996, and covers only six time periods till year 2001. The year 2001 is chosen as the final period because it is the most recent period for which the requisite data are available.

## 5.2 DATA ANALYSIS

This study adopts the generalized output-oriented Malmquist index, developed by Fare et al. (1989), to measure the contributions from the progress in technology and improvement in technical efficiency to the growth of productivity in Malaysian mobile telecommunication industries. The Malmquist indexes are constructed using the Data Envelopment Approach (DEA) and estimated using a program developed by Coelli (1996) called DEAP version 2.1[12].

[12] The DEAP software written by Tim Coelli can be downloaded from his webpage www.uq.edu.au/~uqtcoell/

Malmquist index has been chosen as there are a number of desirable features for this particular study. It does not require input prices or output prices in their construction, which make the method particularly useful in situations in which prices are not available publicly or non-existent. The method also does not require a behavioral assumption such as cost minimization or profit maximization, which make the method useful in situation in which producers' objectives differ, or are unknown or unachieved.

Another attractive feature of the Malmquist index is that it decomposes. This was first demonstrated by Fare et al. (1989) using the geometric mean formulation of the Malmquist index. Following this, Forsund (1991) derived the decomposition of the simple version of the Malmquist productivity index into technical change and efficiency change.

Fare et al. (1994b) listed several traditional methods to calculate the Malmquist productivity index. But most of them require specification of a function form for technology. Charnes et al. (1978) proposed the Data Envelopment Approach to construct a best-practice frontier without specifying production technology. Unlike traditional analysis techniques that look for the average path through the middle points of a series of data, DEA looks directly for a best-practice frontier within the data. Using a non-parametric linear programming technique, DEA takes account of all the inputs and outputs as well as differences in technology, capacity, competition, and demographics and then compares individual with the best-practice (efficiency) frontier. According to Ali and Seiford (1993),

DEA is a well-established non-parametric efficiency measurement technique which has been used extensively in over 400 studies of efficiency in management sciences[13].

## 5.3 OUTPUT AND INPUT SPECIFICATION

Studies on TFP of telecommunication industries show a wide variety of output and input specification. For example Denny et al. (1981) specify six aggregate outputs (local service, Bell toll, Trans toll, U.S. toll, other toll and miscellaneous) and three aggregate inputs (labor, capital and materials)[14]. Nadiri and Schankerman (1981) specify one output (sum of adjusted operating revenues for service categories – local service, intrastate toll, interstate toll and miscellaneous category) and four inputs (labor, capital, intermediate materials, and research and development). Solimene (1994) measures Italian telecommunications industry by defining two different output measures for the two firms *(SIP and ITALCABLE)*. *SIP* outputs consist of number of telephones, number of PARD (Point of Access to Data Network), increase in the number of telephones, number of local calls and total number of minutes for trunk calls. On the other hand, *ITALCABLE* outputs comprise minutes of telephone conversations, minutes of telex messages and minutes of telegraph messages. As for the inputs, capital and total number of labor were considered for the study[15]. Xiaoyu (1996) specify one output (gross output value) and two inputs

[13] They reference a literature review in 1990 with 400 DEA references.
[14] They also provide an alternative measure of aggregate output namely number of local calls, local service revenue, number of telephones, number of residential main stations, number of business main stations, number of toll calls and message toll revenue.
[15] The outputs and inputs for both SIP and ITALCABLE were aggregated using the Tornqvist approximation to the Divisia index.

(capital and labor). Calabrese et al. (2001) evaluate the output by taking the total turnover and for inputs; two variables have been considered which are labor and capital. Daβler, Parker and Saal (2001) aggregate the output into physical output index and consider labor, capital and others as inputs variables. Uri (2001, 2002) specify three outputs (the number of local dial equipment minutes, the number of intraLATA billed access minutes, the number of interLATA billed access minutes) and three inputs (labor, capital and material). In summary, the literature encompasses a wide range of specifications which may have as much to do with data availability as with matters of principle.

Due to data availability issues, only one output and four inputs are considered for this study, which are the number of subscribers as output, and labor and capital as inputs (all measured in quantities). Capital inputs consist of three subcomponents; lands and buildings, mobile switching centers (MSC) and radio base stations (RBS)[16]. Since MSC and RBS equipments act as switching and transmission mechanism, it is reported to be the primary source of growth for telecommunication industries by the Telecommunications Industry Association (2000). Hence, these two equipments are very important input variables apart from the other variables for this study. On the other hand, number of subscribers is chosen as the output variable since it wholly represents the main activities and output of the five operators. It also acts as a proxy to the varieties of services (multiple outputs) offered by the operators such as international roaming, SMS and WAP services. Labor measures include all level of managements in the company irrespective of full-time, part-time or contract staffs.

[16] MSC is a mobile telephone exchange site and RBS is a base transceiver station which provides a radio cell of one or more frequency channels for transmitting a mobile phone cell.

## 5.4 SOURCES OF DATA

The study uses annual data from 1996 to 2001 to compute the TFP for five mobile operators in Malaysian telecommunication industries. The primary sources of the data set are from the compilation made by MCMC from each respective operator. The data include in this source are total number of digital subscribers, total number of employees and total number of MSC and RBS. Secondary data such as total number of land and buildings are obtained from the respective operators' annual reports from the year 1996 to 2001.

The average industrial output and inputs of the five operators from year 1996 to 2001 are presented in Table 5.1. In terms of number of subscribers as the output, Maxis is the largest digital mobile service provider in Malaysia, followed closely by Celcom. TimeCel on the other hand, has the least number of subscribers among the mobile service providers in Malaysia. For the input factors, Celcom has the highest number of labor, nearly twice the number of Maxis. Celcom also has the most capital input compared to other operators in the industry.

Table 5.1: Average output and inputs by operator, 1996-2001

| Operators | Output | Inputs | | | |
|---|---|---|---|---|---|
| | No. of subscribers | No. of labor | No. of MSC | No. of RBS | No. of land and building |
| Maxis | 882 697 | 2 215 | 14 | 1 060 | 9 |
| Celcom | 821 444 | 4 183 | 14 | 1 085 | 30 |
| TM Cellular | 403 686 | 1 066 | 7 | 879 | 14 |
| DiGi | 521 499 | 1 205 | 9 | 971 | 17 |
| TimeCel | 245 849 | 618 | 7 | 633 | 12 |

Sources: Malaysian Communication and Multimedia Commission (MCMC).
Respective operators' annual reports.

Notes: MSC: Mobile switching centers
RBS: Radio base station