

國立交通大學

管理學院(工業工程與管理學程)碩士班

碩士論文

應用資料包絡法於半導體構裝外包廠之績效評比

Apply Data Envelopment Analysis to Performance Ranking
for Semiconductor Packaging Subcontractors



研究生：李昆峰
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中華民國九十三年七月

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摘要

本研究為對於台灣一家半導體公司，以異常發生率、交期達成率、品質稽核表現三項指標來評比其構裝外包廠。應用資料包絡分析法(Data Envelopment Analysis, 簡稱 DEA)的方法來評量外包廠的相對績效，藉由分析的結果作為外包產能分配的依據並指引各外包廠績效改善的方向，此績效評比的結果對於外包管理系統上助益甚大。本文介紹半導體製造流程、該公司的外包業務的管理流程、並簡要介紹 DEA 方法，以逐步暫移除一個高效率的外包廠的方法來間接評比多個高效率外包廠的排名。

關鍵詞：績效評比、資料包絡法、半導體構裝、外包管理系統

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Abstract

Based on the data from a semiconductor company in Taiwan, this research evaluates the subcontractors' performance ranking via abnormality occurrence rate, delivery commit rate and quality audit performance. The DEA method is adopted to assess the subcontractors' related performance, in which the result could be used as the reference for subcontracting capacity allocation, can steer each subcontractor's performance in correct direction for improvement, and can enhance the subcontracting management system. This content introduces semiconductor manufacturing flow, the subcontracting management flow of that company, also introduces the DEA method, using the way of step by step to remove one high efficiency firm then evaluate indirectly the final ranking for many high efficiency subcontractors.

Keywords: Performance Ranking, DEA (Data Envelopment Analysis), Semiconductor Packaging, Subcontracting Management System

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基於對人生旅途中的一個夢想，碩士的學業是我在大學時的一個努力目標，直到十五年後的今日終於完成本論文，也達到了這個長遠的夢想。

很幸運地考取工管所在職專班，但在工作期間來求學的確是蠻辛苦的，常常寫作業至半夜或假日無休下完成功課，在這幾年的求學時間，還好都能得到家人的體諒與支持，同仁們的協助與支援，再加上同學間的互相討論、合作之下，使得以兼顧學業與工作。

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1. Introduction

For the consideration of economic production scale and professional technique, more and more semiconductor integrated device manufacturers (IDM) strategically tend to horizontal division of processes to other manufacturers to attain competition advantage. Most design firms which without fab subcontract the integrated circuit (IC) packaging manufacturing processes. From the fabrication of extended circumstances, we see that the packaging growth is increasing. In a world of capitalization and low-risk appraisal, companies should be able to continue to subcontracting.

For IDMs in Taiwan, more IC design companies are also employ subcontractors for finished wafer production and IC packaging, and testing. How to choose great and suitable subcontractors to fulfill excellent performance to meet customer's demand is the concern of subcontract management for a lot of enterprises. Such as varied product quality, unstable shipment, poor quality system and unqualified customer audit performance drive subcontract management more subtle. We must take more factors into consideration simultaneously. Product category is so huge that they need many subcontracts. In the following, how to rank subcontractor performance to realize the whole performance and furthermore fine tune ideal quota to the subcontractors has become a crucial topic in subcontract management.

Customers today are becoming increasingly concerned with quality, and since subcontractors control the assembly process, this means a company must strive to find subcontractors capable to produce high quality goods. Due to delivery concerns, however, a company may sometimes be forced to rely on a subcontractor that is not qualified to meet a customer's request. An important issue is how to allocate production capacities to the subcontractors. When viewing semiconductor industry as a whole, IC packaging technology is most important at the semiconductor back-end.

Figure 1 is a brief chart of semiconductor manufacturing process flow.

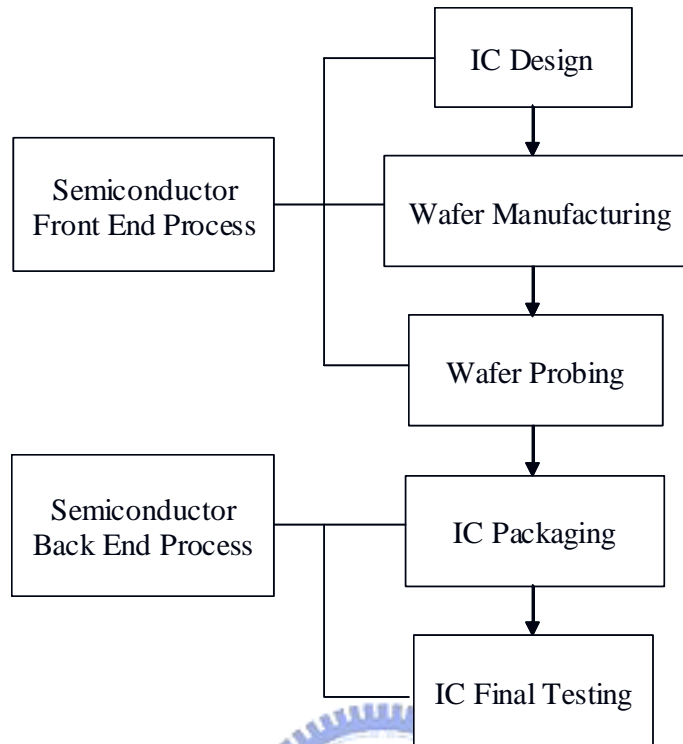


Figure 1
Semiconductor Manufacturing Process flow

This research examines an IDM anonymous as M Company, where the IC packaging process is completed through subcontractors. Its capital is around 20 billion US dollars. Its yearly average revenue of M Company is approximately 7~9 billion US dollars, with the amount paid to assembly subcontractors totaling 0.7~0.9 billion US dollars per year, or 10% of the revenue. Considering this high subcontracting cost, the performance ranking is become more important. We utilize DEA (Thanassoulis, 2001) (Liu, 2003) to evaluate the subcontractors ranking as a reference for subcontracting management. Then, the equitable result is used to plan the capacity allocation, thereby helping steer subcontractor's performance in the correct direction for improvement.

2. Literature Review

2.1 Semiconductor Industry Developing

Reviewing world semiconductor industries (Peng, 2003) in 2003 from the demand side shows the entire economic environment was returned. Most companies have increased the cost expense for information technology (IT) that will increase the growth of personal computer, electronic technology and the semiconductor industry, a clear sign of economic recovery. In 2001 and 2002, capital expenses were reduced to give all the IC fab more effective control. As a result of the market recovery in 2003, it has grown 16% in 2002, totaling approximately 1.64 billion US dollars.

To continue developing the semiconductor industry, IDM and design companies must understand professional technology to achieve competition advantage in the economic dimension. It is beneficial, then, to entrust production to subcontractors. The semiconductor industry leans towards the outsourcing, and currently people are more focused on R&D and thus elect to subcontract for production. The international IDM is now expanding; the IC packaging aspect is more positive; especially Taiwan's IC packaging manufactures have already reached the top of the world and still have room to grow in the future.

2.2 IC Assembly Introductions

In IC assembly (Xie, 1996), plastic material (Epoxy molding compound) is put in a die to create an IC, where most dies are smaller than 1 cm as shown in Figure 2. Millions of electrical circuits need to build up in this tiny area, and all circuits and parts are approximately 0.15~0.4 micro meter. Today, we even have 90 nano meter technical wafer process, and thus the IC is extremely fragile, so that even a small particle can affect it. We can observe from this the importance of the IC assembly.

The IC assembly process has two stages, front-end and back-end. The front-end process includes wafer backside grinding, die sawing, die attachment and wire bonding, while the back-end process has molding, trimming, marking, forming, inspection and packing. During the IC assembly process, the assembly production yield is important to gain the more volume of IC and achieve the target of delivery commit volume for customers. The assembly process should be maintained stable to reduce the abnormality which may cause the defects and induce the potential customer's complaint on application.

These years the IC packaging types are upgraded from conventional types DIP, SO, CC, QFP, and PGA to new ones as TSOP, BGA, CSP, and FC. Due to the packaging technology and equipments capacity improved, and to approach the high pin count, smaller package volume and electrical & thermal requirement, the capacity requirement of new packaging types will be growth very much. Below are the packaging type abbreviations.

DIP : Dual Inline Package

SO : SOP ; Small Outline Package

CC : PLCC; Plastic Leaded Chip Carrier

QFP : Quad Flat Package

PGA : Pin Grid Array

TSOP : Thin SOP

BGA : Ball Grid Array

CSP : Chip Scale Package

FC : Flip Chip

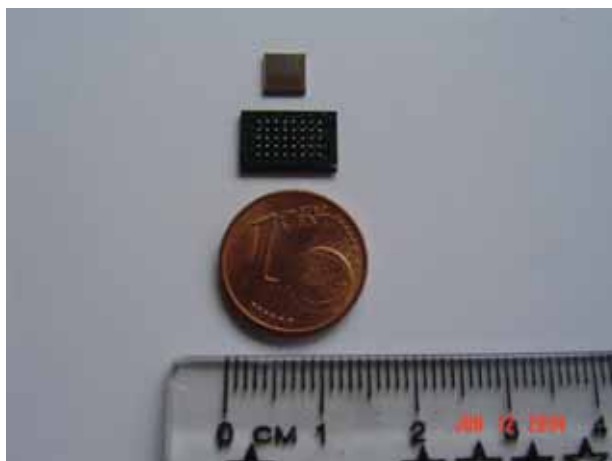


Figure 2
Chip, IC (CSP type) vs. 1 Euro cent coin

Since the Cu process caused IC assembly needs to increase, many Taiwanese traders have started to develop the technical aspect. In fact, elevating IC packaging technology is what IDMs strive for as well. The new assembly demanding has grown, and predictions say assembly gravity of the IC cost will increase. In recent years, the growth of related IC products has been unparalleled throughout the world. One can see the potential of the IC packaging market growing in the semiconductor industry.

2.3 Subcontracting Management

A subcontractor uses spare parts and materials that it owns, and authorizes a company following up with the specification of drawing or layout for the related production. When a company goes in for a production move, its need for materials, processes, and equipment used to make magnetic heads are similar to those used in the semiconductor industry. Examples include very thin conductor and dielectric films and processes/equipment that rely on plasma-based or ion-based systems. (Fu, 1992)

The traditional make-to-buy decision, which determines whether or not a subcontractor should supply a particular component, includes cost, schedule, technical need, resources, and risk as important objectives. (Minis, et al. 1999)

Following the technical improvements prevalent in the corporate strategy, subcontractors have become standard. For a company to complete production total by itself does not make sense economically, especially in work processing in a competitive, intense environment. Therefore, a subcontractor is the fastest and most cost effective method to complete production, especially in the IC assembly industry. (Huang, 2003)

Choosing a suitable subcontractor to support the back-end of IC assembly manufacturing is very important as well. The packaging subcontractor evaluation procedure in M Company is shown in Figure 3.

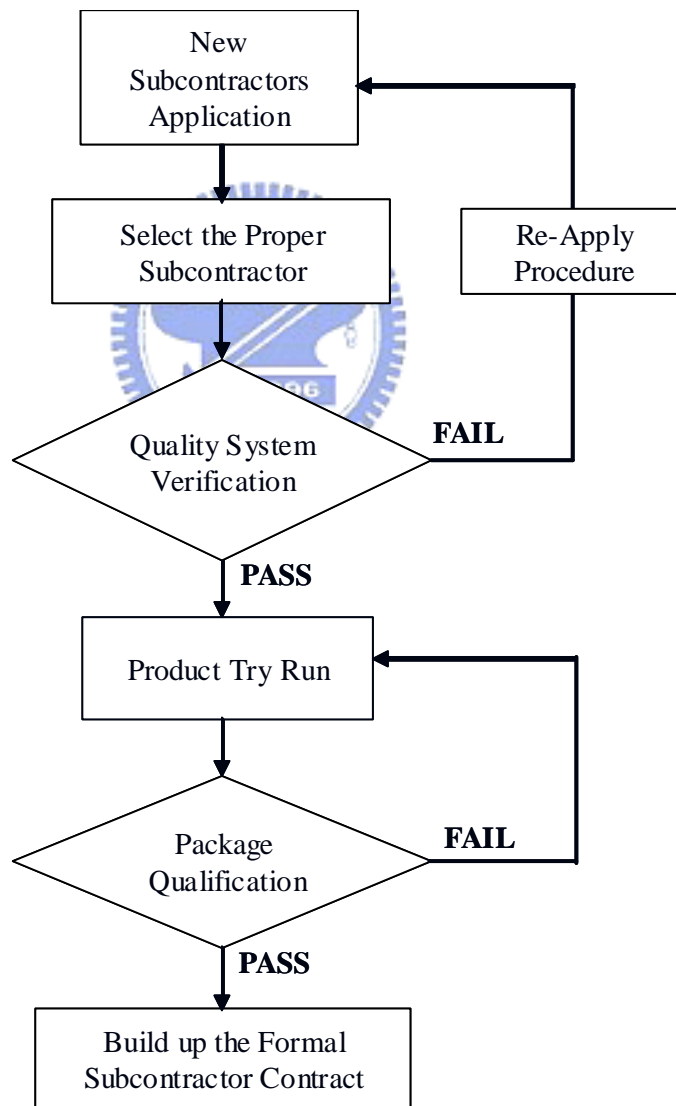


Figure 3
Packaging Subcontractor Evaluation Procedure

IDMs need to consider IC packaging capacity and packaging technology in order to find a suitable subcontractor. To begin the process of choosing a subcontractor, one have to consider some factors, assembly cost for the IC packaging price, pay time, production capability, quality, etc. Then apply the procedure for that new subcontractor. After the application has been approved, one must also ensure the quality system will expect quality requests from both sides. The qualified system is followed ISO9000 international criteria; M Company will audit the quality system for that subcontractor, and define the pass criteria of this audit result. After completing the package qualification which followed the reliability test criteria, once it passes this qualification then that subcontractor could get the formal contract with M Company. We must also ensure that there is a high level of productivity quality and control, and make sure the qualification rate is high to pass.

In semiconductor manufacturing industry, IC process technology has been elevated and the assembly technology requirements have risen, so new products and demand for them come out often. If IC assembly manufacturing is deficient in professional technology or consideration for quality concern, delivery commit rate, and different kinds of risk, the IC industry needs to assume a suitable management method to meet the demand.

IC semiconductor industry implements supply chain management system. Subcontractors are a main point of consideration, and another main subject is production capacity allocation. The subcontracting management system of M Company is shown in Figure 4.

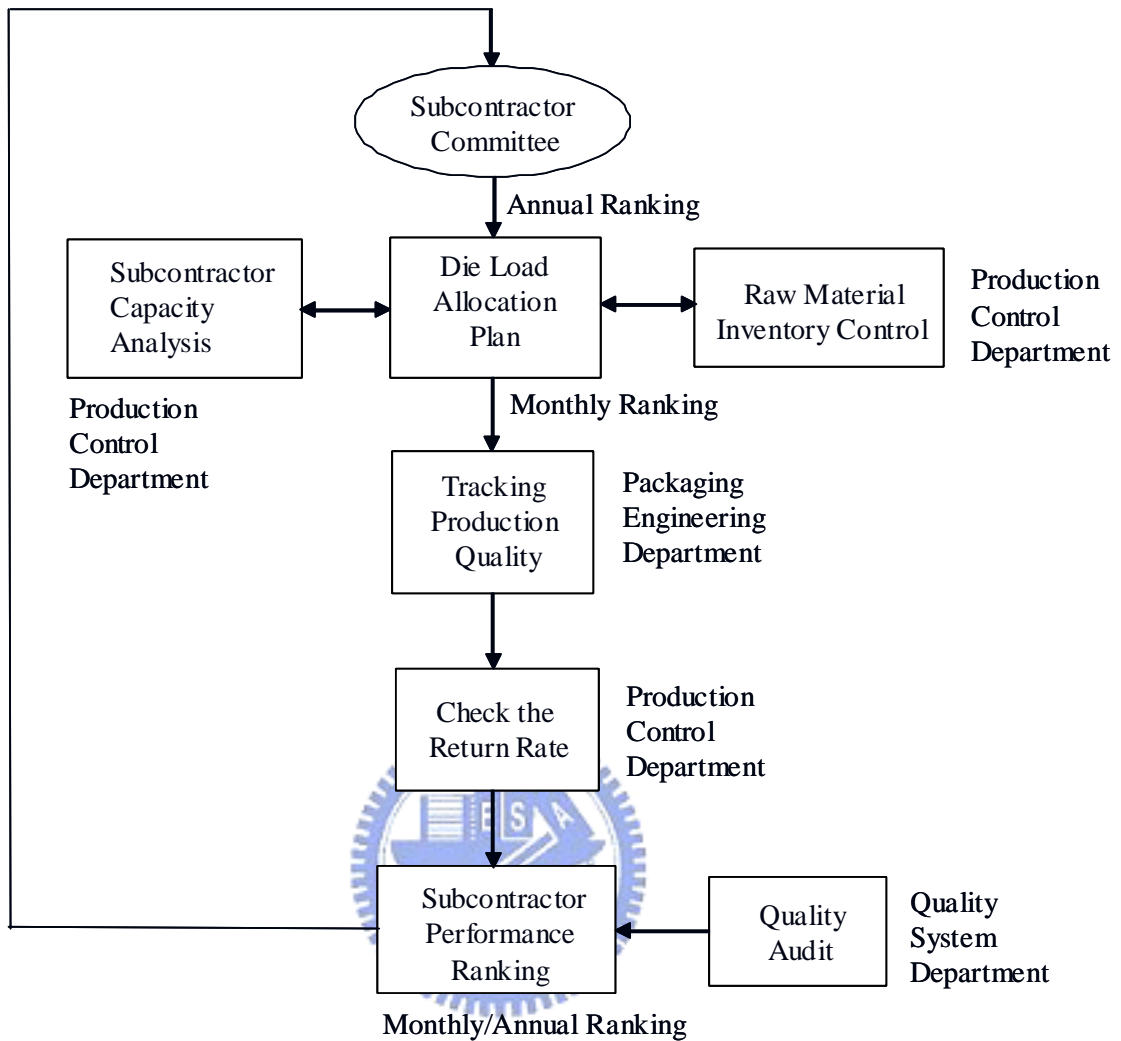


Figure 4
Subcontracting Management System

On a subcontractor committee, the vice president is the director, while other members include the head of decision strategy, finance of purchases department, the head of the packaging engineering department, capacity control department, quality system department, etc. They decide the capacity allocation for all subcontractors in the meeting, and then provide a performance ranking record for subcontractor committee reference.

After capacity allocation every year, the capacity control department prepares for the product, and examines the monthly performance results. According to the capacity allocation, capacity control will deal with any sudden change orders, quality concerns, capacity problems and customer special requests to achieve the integration of subcontracting management.

Due to the performance ranking will impact the die load percentage for each subcontractor, it's very important to have fair criteria for this ranking system. Current ranking methodology is used many indices which with more personal decision factors, these data are subjective and could not been evaluated the precise ranking. We want to have a more objective indices and a reliable methodology to conduct IC packaging subcontractors' performance ranking, the DEA model could be provided a more objective method to analyze ranking data.



3. Research Method

3.1 Units for performance assessment

We employ DEA to assess the relative performance of all existing packaging subcontractor firms of M Company. The seven subcontractors' anonyms are EKS, BKS, STC, MTA, JCM, GRK, and PTL.

3.2 Performance Ranking Index Selection

We considering the IC packaging related factors and subcontracting management related requirement, in the beginning there are possible eight indices for performance assessment as listed in Table 1. Four of them are not proper to use, two of four indices are combined to one. Adding the remaining two indices, finally, only three indices are used for performance assessment.



Table 1
Performance Ranking Index Analysis

Index	Definition	Selection
Packaging price	The IC packaging cost for assembly of each packaging type in subcontractors.	No
Production yield	The percentage of successful IC packaging volume.	No
Pay time	Time to pay the IC packaging cost to subcontractors	No
Product certification rate	The successful certified rate of new product in IC packaging, which failure result will affect the marketing time or mass production timelines.	No
Customer complaint quantity	IC packaging defect case of customer complaints after shipping out.	Yes
Production abnormality quantity	During IC packaging the process abnormalities happened times, usually this event cause IC waste or shipping delays and may impact the shipping requirement.	Yes
Delivery Commit rate	Volume completion refers to IC volume delivery percentage while comparing returning volume with input volume in a designated time. Maximum rate is 100%.	Yes
Quality audit performance	Monthly or annual quality system audit performance, must maintain good condition. The higher the audit score, the better quality performance. The maximum score of this audit performance is 100 scores.	Yes

The reasons for not selecting the first four ranking indices: Packaging cost is depends on different IC packaging types which are hard to identify fair evaluation criteria for different subcontractors. The production yield is getting stable and better which without significant difference between different subcontractors. The pay time almost could be longer than 3 months so that it's not important. Due to M Company occasionally asks for certifying new products, we do not keep the data about certification rate for subcontractors.

Through accessibility evaluation and analysis, we get four ranking indices. Considering the current seven subcontractors, we incorporate two indices “customer complaint quantity” and “production abnormality quantity” into one as “production abnormality quantity”. Besides “delivery commit rate” and “quality audit performance”, we have three ranking indices to evaluate subcontractors’ performance. Process abnormality quantity changes following input volume. If productivity and abnormality quantity are low, it cannot stand for its production quality and control capability. If productivity is high and abnormality quantity is low, it means production quality and control capability is stable. We modify this index as abnormality occurrence rate (The rate of abnormality per million ICs), which illustrates characteristics and capabilities of ample packaging. According to the three measurement indices, we collect the actual production data for further analysis. The data and their notations from each packaging subcontractor performance in 2003 are depicted in Table 2.

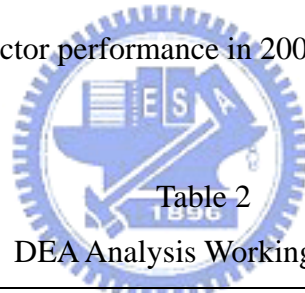


Table 2
DEA Analysis Working Table

Firms		Abnormality occurrence rate	Delivery commit rate %	Quality audit performance
j	Name	X_1	Y_1	Y_2
1	EKS	x_{11} 0.59	y_{11} 96.52	y_{21} 80
2	STC	x_{12} 0.56	y_{12} 99.30	y_{22} 79
3	BKS	x_{13} 0.84	y_{13} 97.30	y_{23} 72
4	MTA	x_{14} 1.69	y_{14} 92.50	y_{24} 62
5	GRK	x_{15} 4.94	y_{15} 93.80	y_{25} 71
6	JCM	x_{16} 0.88	y_{16} 86.80	y_{26} 70
7	PTL	x_{17} 0.45	y_{17} 83.70	y_{27} 61

3.3 Efficiency Score

We use the following notations for the DEA models employed in this paper.

X_1 : Abnormality occurrence rate (case per million ICs)

Y_1 : Delivery commit rate (%)

Y_2 : Quality audit performance (score 100 extremely)

x_{1j} : denotes the value of *Firm-j* on index X_1

y_{1j} : denotes the value of *Firm-j* on index Y_1

y_{2j} : denotes the value of *Firm-j* on index Y_2

v_1 : Weight of index X_1

u_1 : Weight of index Y_1

u_2 : Weight of index Y_2

Larger values at Y_1 and Y_2 and smaller values on X_1 indicate the superior performance of a firm. Therefore, one may use the following equation to measure the efficiency of each firm, *Firm-j*. Smaller x_{1j} would give larger P_j value while larger y_{1j} or y_{2j} will lead to a larger P_j value.

$$P_j = \frac{y_{1j} \times u_1 + y_{2j} \times u_2}{x_{1j} \times v_1} \quad (1)$$

3.4 DEA Model Selection

Charnes, Cooper and Rhodes (1978) proposed a new DEA model, the CCR model, which expands on Farrell's (1957) works to measure production efficiency under multiple inputs and outputs by the same scope. In this paper, we use the indices of quality, delivery, and abnormal rate to evaluate the subcontractors' performance through ranking and suggesting improvements. We use the input-oriented model, CCR-I, as the evaluation model, to reduce the input index and increase the output index in order to meet the high efficiency. The following model [CCR-I-FP_k] is employed to measure the relative efficiency of *Firm-k*. Every firm alternates as the object so that k is ranged from 1 to 7.

[CCR-I-FP_k]

$$\text{Objective function: maximize } P'_k = \frac{y_{1k}u'_1 + y_{2k}u'_2}{x_{1k}v'_1}$$

$$\text{Subject to } P'_j = \frac{y_{1j}u'_1 + y_{2j}u'_2}{x_{1j}v'_1} \leq 1 \quad (j = 1, 2, \dots, 7)$$

$$v'_1, u'_1, u'_2 \geq \varepsilon > 0$$

is a Archimedean infinitesimally small number.

The objective is to have a maximum efficiency score for the object *Firm-k* while the seven constraints limit the efficiency scores for each *Firm-j* is no more than one. [CCR-I-FP_k] model is a fractional programming model and is transformed into a linear programming model as below. The lower bound conditions for the decision variables u_1 , u_2 and v_1 would guarantee the proper transformation.

$$\text{Max } P'_k = \frac{y_{1k}u'_1 + y_{2k}u'_2}{T}$$

$$\text{Subject to } x_{1k}v'_1 = T \quad (j=1,2,\dots,7)$$

$$y_{1j}u'_1 + y_{2j}u'_2 - x_{1j}v'_1 \leq 0$$

$$v'_1, u'_1, u'_2 \geq \varepsilon > 0$$

$$\text{Let } u_1 = \frac{u'_1}{T}, u_2 = \frac{u'_2}{T}, v_1 = \frac{v'_1}{T}$$

Therefore, [CCR-I-FP_k] can be rewritten as [CCR-I-LP_k].

[CCR-I-LP_k]

$$\text{Max } P_k = y_{1k}u_1 + y_{2k}u_2$$

$$\text{Subject to } x_{1k}v_1 = I$$

$$y_{1j}u_1 + y_{2j}u_2 - x_{1j}v_1 \leq 0 \quad (j=1,2,\dots,7)$$

$$v_1, u_1, u_2 \geq \varepsilon > 0$$

Transformed from primal model CCR-I, we get the dual model.

[CCR-I-DLP_k]

$$\text{Min } \theta_k - \varepsilon(s_1^- + s_1^+ + s_2^+)$$

$$\text{Subject to } \theta_k x_{1k} - x_{11}w_1 - x_{12}w_2 - \dots - x_{17}w_7 - s_1^- = 0$$

$$y_{11}w_1 + y_{12}w_2 + \dots + y_{17}w_7 - s_1^+ = y_{1k}$$

$$y_{21}w_1 + y_{22}w_2 + \dots + y_{27}w_7 - s_2^+ = y_{2k}$$

$$w_1, w_2, w_3, w_4, w_5, w_6, w_7 \geq 0$$

$$\theta_k \text{ free in sign } \quad s_1^-, s_1^+, s_2^+ \geq 0$$

The decision variables $w_1, w_2, w_3, w_4, w_5, w_6, w_7$ are the weights assigned to the Firms, respectively, that are participating the relative performance measurement for the object *Firm-k*.

The solution of CCR-I-DLP_k will have some differences due to the setting of ε , so we use the two-phase solution to solve [CCR-I-DLP_k].

Phase I - Obtaining the best θ_k^*

[DLP_{k-I}]

$$\text{Min } \theta_k$$

$$\text{Subject to } \theta_k x_{1k} - x_{11}w_1 - x_{12}w_2 - \dots - x_{17}w_7 \leq 0$$

$$y_{11}w_1 + y_{12}w_2 + \dots + y_{17}w_7 \leq y_{1k}$$

$$y_{21}w_1 + y_{22}w_2 + \dots + y_{27}w_7 \leq y_{2k}$$

$$w_1, w_2, w_3, w_4, w_5, w_6, w_7 \geq 0$$

$$\theta_k \text{ free in sign}$$

Phase II - Obtaining the optimum slacks of the indices $s_1^{-*}, s_1^{+*}, s_2^{+*}$

[DLP_k-II]

$$\begin{aligned} \text{Max} \quad & s_1^- + s_1^+ + s_2^+ \\ \text{Subject to} \quad & x_{11} w_1 + x_{12} w_2 + \dots + x_{17} w_7 + s_1^- = \theta_k^* x_{1k} \\ & y_{11} w_1 + y_{12} w_2 + \dots + y_{17} w_7 - s_1^+ = y_{1k} \\ & y_{21} w_1 + y_{22} w_2 + \dots + y_{27} w_7 - s_2^+ = y_{2k} \\ & w_1, w_2, w_3, w_4, w_5, w_6, w_7: \quad 0 \\ & s_1^- \quad 0, s_1^+ \quad 0, s_2^+ \quad 0 \end{aligned}$$

s_1^- : The excess of index X_1 indication for *Firm-k*

s_1^+ : The shortfall of index Y_1 output indication for *Firm-k*

s_2^+ : The shortfall of index Y_2 output indication for *Firm-k*

Using Microsoft Office-Excel tool “Solver” (Cooper et al, 2002), one could solve the model [DLP_k-I] and [DLP_k-II] and get the optimal solution of $\theta_k^*, s_1^{-*}, s_1^{+*}, s_2^{+*}$. Simultaneously, the dual optimal solution of $P_k^*, v_1^*, u_1^*, u_2^*$ from FP_k model are obtained. Then the efficiency of *Firm-k* is:

$$P_k^* = \frac{y_{1k} u_1^* + y_{2k} u_2^*}{x_{1k} v_1^*} \quad (2)$$

where $P_k^* = \theta_k^*$

If $\theta_k^* = 1, s_1^{-*} = s_1^{+*} = s_2^{+*} = 0$, then *Firm-k* is an efficient one.

If $\theta_k^* = 1, s_1^{-*} + s_1^{+*} + s_2^{+*} > 0$, then *Firm-k* is a weak efficient one with efficiency score equals one but still needs improvement on some indices.

If $\theta_k^* < 1$, then *Firm-k* is an inefficiency one.

4. Research Result and Analysis

4.1 Measurement Analysis

Table 3 summarizes the results of the performance measurement. θ_2^* and θ_7^* equal to 1 and s_1^{-*} , s_1^{+*} , s_2^{+*} are all equal to 0, so that *Firm-2* and *Firm-7* are efficient. θ_3^* and $\theta_5^* < 1$ with all s_1^{-*} , s_1^{+*} , s_2^{+*} equal to 0, *Firm-3* and *Firm-5* are pure inefficient firms.

In the CCR model, every inefficient firm has one efficient target for improvement direction. By examining Table 3, we find *Firm-2* and *Firm-7* are the reference ones for *Firm-3* with weighs 0.16 and 0.97, respectively. In other words, the reference target of *Firm-3* is the linear combination of *Firm-2* and *Firm-7*. There is only one reference efficient point *Firm-2* for *Firm-1* and *Firm-6*, and the reference efficient point *Firm-7* for *Firm-4*. The other weights not shown are equal zero.

Another consultable key point is that if the firm's efficiency and reference target is not itself, the firm has a low efficiency. We can identify *Firm-2* and *Firm-7* as genuine efficiency.

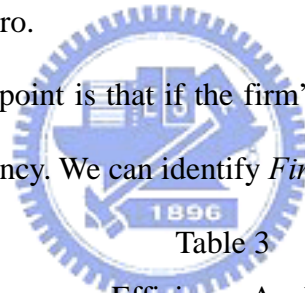


Table 3
Efficiency Analysis

k	θ_k^*	w_2^*	w_7^*	s_1^{-*}	s_1^{+*}	s_2^{+*}	Rank
1	0.96	1.01	0	0	4.03	0	3
2	1	1	0	0	0	0	1
3	0.63	0.16	0.97	0	0	0	4
4	0.29	1.11	0	0	0	5.41	6
5	0.10	0.40	0.65	0	0	0	7
6	0.56	0.89	0	0	1.19	0	5
7	1	0	1	0	0	0	1

4.2 Performance Ranking Result

According to the above analysis, the most efficient firms are *Firm-2* and *Firm-7*. To further understand the influence of these two firms, we use Jackknifing method (Ruggiero, 2002). Remove *Firm-7* from the data set, six firms are compared each other, and perform the CCR-I analysis. Then, measure the relative efficiencies of the six firms with the absent of *Firm-2*. The efficiencies are recorded in table 4. The last row is the sum of the six efficiencies, 3.62 and 3.59. It indicates of *Firm-2* has stronger impact on the relative efficiency scores.

Table 4
Efficiency Subcontractors Influence Analysis

<i>k</i>	<i>Firm-k</i>	<i>Firm-2</i> absented	<i>Firm-7</i> absented
1	EKS	1	0.96
2	STC	-	1
3	BKS	0.63	0.65
4	MTA	0.29	0.31
5	GRK	0.11	0.11
6	JCM	0.59	0.56
7	PTL	1	-
Sum		3.62	3.59

4.3 Subcontracting Capacity Allocation

Administration mechanisms on subcontracting capacity allocation are crucial to an IDM company who subcontracts the packaging process. We must take into account many factors, including throughput production, quality conditions on diverse process and product lines, shipment capability, special customer requirements, and so on (Zhou, 2003). These factors affect subcontractor throughput dispersion. The integral ranking on this research provides an excellent reference point. Although we cannot take every individual factor into consideration, we are at least aware of each subcontractor's strengths and performance for the base of annual capacity allocation.

Based on the above performance ranking result and analysis, we can recommend larger capacity allocation (60~80%) for the top 3 ranked firms, *Firm-2*, *Firm-7* and *Firm-1*, while the 4th ranked *Firm-3* and 5th ranked *Firm-6*, should receive the second largest capacity allocation (10~30%). The last two subcontractors, *Firm-4* and *Firm-5*, get the least capacity allocation since their whole performance is too far behind their competitors and therefore, improvement is required.

5. Conclusion

In today's increasingly competitive semiconductor industry, a good performance is extremely important. When certain processes must be subcontracted for production, one must select quality subcontractors. Meanwhile, ranking activity is crucial because ranking results will decide the quantity and percentage we intend to die load, making a good ranking system imperative.

We usually discover that the conclusion differs following different directors on the ranking. DEA provides us with a more objective method to analyze rating data. DEA explores and analyzes using mathematical modes to provide an improvement reference target and direction in our practical operations to extract an optimum rating target. We can accomplish this optimum performance through these improvement indications. Yet this kind of analysis method only provides relative efficiency evaluation, not absolute efficiency assessment. Since the mode of evaluation is relative, correct data is the key to achieving high efficiency results. These data should also reflect fairness and objectivity.

This research successfully applied DEA to complete packaging subcontractor performance rankings for the IDM. We collected valuable data to judge subcontractor performance and help make proper subcontractor capacity allocation decisions. To an administrator, this is an excellent management indicator.

In the future, we can apply the subcontractor ranking system to conduct subcontractor rankings precisely and consistently. While in annual integral subcontractor capacity allocation, it can act as an annual ultimate rating. In monthly dynamic management, adjusting throughput or quality ratings are maneuverable. We can take into consideration proper performance indices such as a monthly rating using DEA methodology. These rating data are able to accurately capture sufficient information to construct a perfect performance ranking and throughput strategy arrangement. Also, it could be applied to new product performance rankings or staff performance, to set up a precise and solid ranking structure.

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Authors' Biographies

Kun-Feng Lee had his bachelor degree from the Department of Electrical Engineering of Fung Chia University. He is working in an integrated device manufacturer company as a manager of Subcontracting Engineering Department. He gains experiences in semiconductor IC packaging manufacturing technology for more then ten years, also with more subcontracting management experiences and well knows the subcontracting system.

