

# Integrating Grey Relational Analysis and Multi-Dimensional Scaling for TFT-LCD Competitiveness

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**Abstract.** There are some fundamental changes in TFT-LCD industry can be envisioned. The major players in South Korea, Japan and Taiwan have been investing heavily on TFT-LCD production since 1993 and possess a pivotal position of value chain in consumer electronics. However, due to the global financial crisis occurred from 2007, the global demand dropped sharply in an unexpectedly way. It is expected to have more challenges to face under conditional economy recovery and the emerging market in China where may boost more demand gradually. How to prevail among worldwide competition to embrace next phase of excellence in TFT-LCD industry is worth to pay attention. Most of the vendors continue to invest resources to increase their competitiveness. Not many researches analyze the effectiveness of their massive investments to pursue global competitiveness. Therefore, the purposes of this paper center on: 1) Analysis and comparison of current capacity and trends for global TFT-LCD key players; 2) Collecting data from financial statements and business performance in 2009 to conduct a longitude survey; 3) Analysis and suggestion of TFT-LCD competitive strategy and positioning through Multi-Dimensional Scaling (MDS) and Grey Relational Analysis (GRA) assessment.

**Keywords:** Thin Film Transistor-Liquid Crystal Display (TFT-LCD), Multi-Dimensional Scaling (MDS), Grey Relational Analysis (GRA), Competitiveness

## 1. Introduction

Welcome to The 2010 International Conference on Chemical Engineering and Applications (CCEA 2010). The Conference is a primary international forum for scientists and technicians working on topics relating to Chemical Engineering and Applications. It will provide an excellent environment for participants to meet fellow academic professionals, to enhance communication, exchange and cooperation of most recent research, education and application on relevant fields. It will bring you new like-minded researchers, fresh idea. It also provides a friendly platform for academic and application professionals from crossing fields to communication together.

## 2. Industrial Evolution of TFT-LCD

Our topic stresses on the operation efficiency and positioning analysis for global top 10 TFT-LCDs. Hence, this section describes the development of TFT-LCD industry evolution, industrial chain, and current status.

### 2.1. TFT-LCD Historical Development

TFT-LCD was first invented by American RCA Laboratories in 1962, but Japan was the first mover to apply TFT-LCD panel display and commercialize LCD technology. After 20 years, the engineer of Seiko in Japan first used it to mini TV. Until 1988, Sharp produced the first piece of 14-inch display screen, and even after extended to larger screen usage (Shyu et al, 2005). It is expected the large-size panel will be the major products based on the estimated value from a global point of view. In 2003, the production value of large TFT-LCD panel (over 10 inches) contributed 56% of the total values (204 billion out of 352 billion US dollars). In 2005, the large panel value was even more significant up to 70%. In fact, according to the latest statistics by Display Search showed that the global flat panel display output in 2005 reached 74 billion US dollars, representing a growth of double as in 2004, of which TFT-LCD occupied over 80% with 600 billion dollars

In general, TFT-LCD is characterized low power consumption, high resolution, ultra lightweight, sustainable, and free of radiation. In term of large-scale TFT-LCD industry characteristics, it includes

capital-intensive, technology-intensive, short product life cycle, price is subject to supply-demand and business cycles, and international divergence. In other words, to remain competitive advantages, firms have to continuously increase investment, expand production capacity, enlarge critical mass, and improve R&D or pursue research excellence. They also need to establish strategic alliance or vertical integration to ensure partnership with upstream and downstream firms, for the purpose of stabilizing purchase cost and customers when needed. (Shyu et al, 2005).

## 2.2. TFT-LCD Supply Chain

The supply chain of TFT-LCD can be divided into upstream as materials and key components, middle-stream as panel factory and module plant, and downstream as system and module factory as shown in Figure 3 as one example in Taiwan. The upstream manufacturers can be further categorized into mask, polarizing film, backlight module, driver IC, LCD, cold cathode fluorescent lamp, color Filter, and glass substrate. The middle-stream can be classified as large panel and small panel manufacturers. The firms in downstream include TV makers, PC/NB makers and consumer electronics makers. The middle part of this supply chain enjoys the largest annual output value (close to 2 trillion NT\$). The world's leading manufacturers are primarily located in Korea, Taiwan and Japan with 83% of total global market share. Therefore, this study aims to analyze global top 10 firms including AUO, CHIMEI, CPT, Hann Star, INNOLUX, Samsung, LG Display, Sony, Sharp and Toshiba from these three major countries.

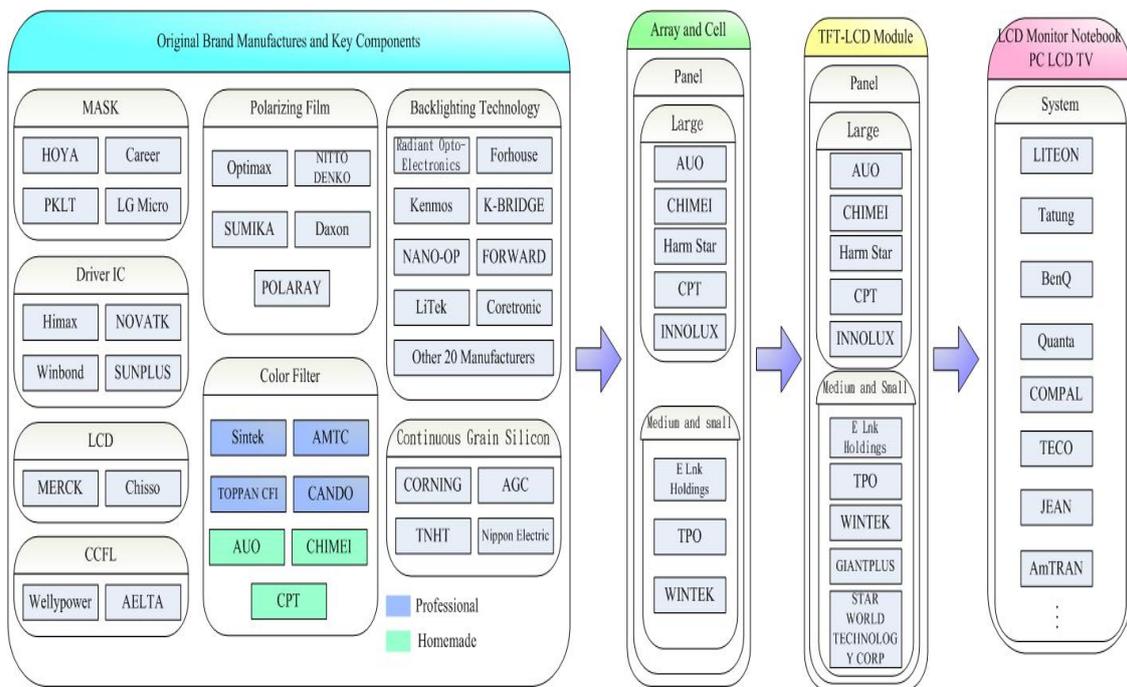


Fig. 1: TFT-LCD Supply Chain in Taiwan.

Source: IEK, ITRI

## 2.3. Empirical analysis

This section explains the empirical research based on MDS model, and use SPSS software to calculate the attribute vector and the normalized regression coefficient of each regression line. It discloses the attribute vector and individual joint space maps. In this study, X-axis is identified as output dimension and Y-axis is defined as the input dimension. The longitude analysis is undertaken from 2009 respectively.

Table 1: The Attribute Vector of Financial items in 2009

Financial Indicator \ Item	R2	Normalized Regression Coefficient		Dimension Angle	Adjusted Dimension Angle
		b1	b2		
R&D Cost	0.791	0.06	0.365	9.33	9.33
Fixed Asset	0.995	0.234	-0.127	-61.51	-61.51
Intangible Asset	0.745	0.247	0.118	64.46	64.46
Equity	0.417	0.13	0.112	49.25	49.25
Cash	0.981	0.241	-0.129	-61.84	-61.84
Revenue	0.988	-0.232	0.158	-55.74	-55.74
Profit before Tax	0.987	-0.228	0.184	-51.10	-51.10
ROE	0.727	-0.175	-0.14	51.34	231.34
ROA	0.754	-0.187	-0.134	54.38	234.38

In 2009, the starting coordinate of attribute vector and the dimension angle of each financial item are: R & D coordinate is (0.06,0.365), dimension angle is 9.33; Fixed Asset coordinate is (0.234,-0.127), dimension angle is -61.51; Intangible Asset coordinate is (0.247,0.118), dimension angle is 64.46; Equity coordinate is (0.13,0.112), dimension angle is 49.25; Cash coordinate is (0.241,-0.129), dimension angle is -61.84; Revenue coordinate is (-0.232,0.158), dimension angle is -55.74; Profit before Tax coordinate is (-0.228,0.184), dimension angle is -51.1; ROE coordinate is (-0.175,-0.14), dimension angle is 231.34; ROA coordinate is (-0.187,-0.134), dimension angle is 234.38. The details are shown in Table 1 and Figure 2.

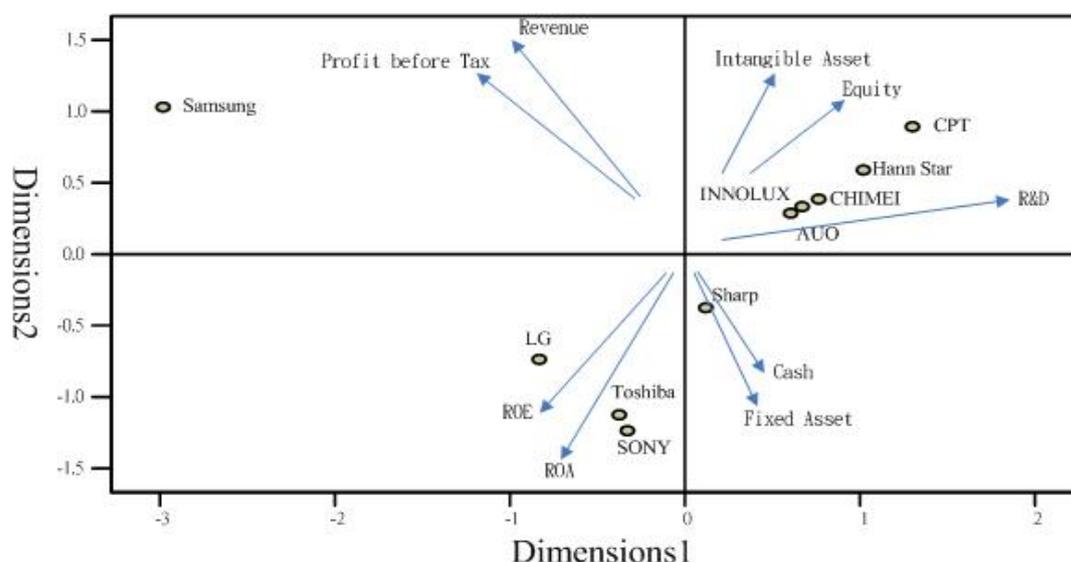


Fig. 2: Joint Space Map of TFT-LCD in 2009.

### 3. Conclusion

In this study, a large-scale global production and well developed industry has been analyzed. The longitude survey from 2002 to 2009 has conducted to investigate the dynamic competitive positioning analysis. Research findings reveal Samsung is the market leader in TFT-LCD industry. They have reached critical mass in terms of inputs and outputs, and continuously invest on technology and process innovation to pursue next-generation manufacturing. They also attempt to get rid of LG and AUO. LG, AUO and CHIMEI are market challenger. Especially AUO ever excelled Samsung in 2007 and 2008, but impacted by global recession. It led to AUO from market leader to market challenger. Market followers include Hann Star and CPT. They also impacted by financial crisis and changed the position from market follower to niche market taker. Market niche taker is consists of Sony, Sharp, Toshiba and INNOLUX. Japanese companies focused on high added-value technology and process innovation instead of pursuit of industrial chain leading

advantage by giving up the competition of capacity scale. INNOLUX strengthens the downstream integration and build up strategic alliance with distributors. Moreover, market leader normally has the largest market share, pricing setting and develop new business model like Samsung. Market challenger refers to those company aggressively want to increase market share to improve investment returns and profit goals, such as AUO and CPT. Market followers aim to maintain existing market share, and shape the uniqueness and attractiveness, such as CHIMEI and Hann Star. Market niche taker indicates the company target smaller market segments and provide specialized services, such as Sony, Sharp and Toshiba.

TFT-LCD industry is facing rapidly advanced technology and new product innovation, coupled with the shorter product life cycle. It may disadvantage their finance and business if fail to face the technological change. TFT-LCD manufacturers in Taiwan can adjust strategy gradually to transform OEM oriented business strategy, and collaborate with upstream and downstream firms strategically. They can save R&D cost by obtaining technology support from the upstream venders, also increase profitability by cooperating with downstream firms to prevent the competition from Korea and Japan strong brands. The business model of INNOLUX can be a best practice. In the consumer electronics industry (including large flat panel TV, multi-media appliances), Korea and Japan has its own brand, while Taiwan's brand appear weaker. Even both Taiwan and Korea have largest capacities and investments.

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