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子計畫 8:CNT 技術對平面顯示器產業發展之影響(1/3)

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摘要

隨著市場環境劇烈地變化，新科技發展被企業視為最重要的競爭利器。根據PDMA 調查，成功的高科技公司，其新產品營收佔總營收的50%。因此，企業必須了解成功的新產品發展(new product development, NPD)，是企業維持競爭力以及生存的必備條件。雖然，成功的新科技可以為企業帶來競爭優勢，相反地，選擇不適當的新科技或錯誤的決策則會導致巨額的財務及人力資源的耗損。因此，如何再每一個新產品發展階段()適時地評估新科技被視為重要的管理議題，特別是在初始的篩選階段(screening stage)的評估。

故本研究將提出一個可行系統性的評估方法處理科技評估之議題，其中，評估方法主要包含兩大部分(1) 選擇評估指標。過去文獻大多著重於市場、財務、技術構面，然而，新科技是否能順利量產至商品化階段，其關鍵考量因素在於新科技製造之可行性。因此本研究透過專家訪談以及文獻蒐集，將製造構面納入評估考量，並整理出更為全面性之評估指標;(2)建立評估程序。本研究運用Analytic Hierarchical Process (AHP)方法計算評估指標之間的重要程度，並得到相對權重。最後使用評分量表評估新科技在每一指標的績效，以獲得新科技之總體分數。最後，本研究以被視為具潛力的新科技-奈米碳管背光模組(Carbon Nano Tubes Backlight units, CNT-BLUs)作為個案進行評估與探討。

關鍵字：新科技評估、奈米碳管背光模組(CNT-BLUs)、層級分析法(AHP)

1. Introduction

Recently, technology is sincerely considered as one of the most driven forces of competitive advantages for business. According to the finding of PDMA, more than 50% of the sales in successful high technology companies were coming from new product, and the percentage was over 60% in the most successful overall company. Therefore, the companies should realize that it is critical to accelerate new product development (NPD) for their survival and the competitive success. Although the successful NPD will lead the companies to competitiveness, selection of inappropriate will result in significant losses of financial and human resources. Therefore, it is quite important that product managers evaluate the viability of a new product at every stage of its development, especially the initial screening stage.

In comparisons with previous study in this area, most literature focused on technological and financial aspects. As aimed at these issues, this study devises a feasible and systematical mechanism based on AHP and scoring techniques to deal with the technology evaluation and provides more complete evaluative criteria; especially bring Manufacturing aspect into evaluative consideration. Finally, this study implements a promising technology- Carbon Nano Tubes Backlight units (CNT-BLUs) to proposed evaluative mechanism and analyzed the result.

Keywords：New technology evaluation, CNT-BLUs, AHP

2. Research Objective

The NPD process is complex and involves varieties and uncertainties of environment problems including technological competitiveness; customer needs, manufacturing feasibility, and financial funds. These uncertainties lead to dependencies between and among cross-functional areas (e.g. technologist, marketing, finance, and manufacturing) to accomplish the technology evaluation at every stage in the NPD process. Furthermore, lack of real and specific data obtained and both qualitative and quantitative required considered result in difficulties of evaluation increasing. Therefore, the systematic evaluation procedure incorporating cross-functional views of technological, marketing, financial, and manufacturing for technology evaluation is essentially required to reduce uncertainty of decision-making. As an aid to the resolution of these problems, AHP approach is proposed to address the decision-making problems in evaluating technology. The AHP is viewed as a flexible multi-criteria decision making technique for problems where both qualitative and quantitative aspects considered based on subjective judgments. In this study, the AHP is applied in selecting evaluative criteria and then these criteria are utilized in evaluating single technology based on scoring technique.

As mentioned above emphasis on needs and issues of technology evaluation, this study proposes the methodology which is implemented by AHP and scoring techniques for technology evaluation. The main purpose of study is to develop a evaluation process including selecting criteria, relevant weighting criteria, and evaluating specific technology based on types of technology also known as R&D project. Therefore, drawing on the foregoing review of the relevant literature, the specific research questions that guided our study were as below:

1. Which evaluative model or procedure is appropriated to be followed?
2. Which criteria are used most frequently at the NPD evaluation gates?
3. How to acquire the weights of criteria on the basis of AHP approach?
4. How to apply the promising technology –CNT-BLU to proposed methodology in this study?

3. Literature Review

3.1 Types of Technology

Ansoff's (1957) devised original product/ market matrix, arrays projects based on newness to the market and newness to the company into six categories (See Figure3.1).

1. ***New to the World*** (NTW)-New products that create an entirely new market.
2. ***New to the Company*** (NTC)-New products that for the first, allow a company to enter an established market.
3. ***Additions to Existing Product Lines*** (AEL)-New products that supplement a company's established product lines.
4. ***Improvements in/Revisions to Existing Products*** (IM) - New products that

provide improved performance or greater perceived vale and replace existing products.

5. ***Repositioning*** (RP)-Existing product targeted to new markets or market segments.
6. ***Cost Reducing*** (CR)-New products that provide similar performance at lower cost.

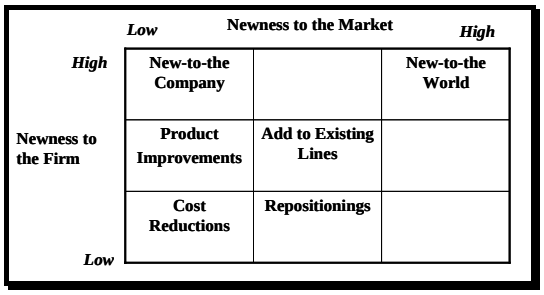

Figure 3.1 Types of Technology

3.2 Entire Innovation Process

The entire innovation process can be divided into three main areas: (1) Fuzzy front end (FFE), (2) New product development (NPD), (3) Commercialization, as indicated in Figure 3.2.

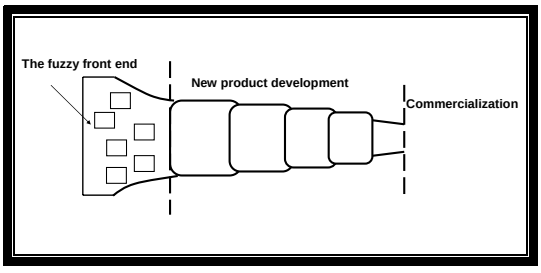

Figure 3.2 Innovation Process [1]

3.3 Evaluation Methods

According to Sounder *et al.* (1986), the project evaluation and selection models can be categorized in into (1) classical methods, (2) portfolio models, (3) project evaluation techniques, (4) organizational decision methods [2].

Regarding to models for evaluation and selection project, Henriksen *et al.* (1999) proposed more overall classifications, and thereby inducted numerous methods or techniques into one of the following categories [3][4]:

1. **Unstructured peer review**
2. **Scoring Model**
3. **Mathematical programming**, including integer programming (IP), linear programming (LP), nonlinear programming (NLP), goal programming (GP), and dynamic programming (DP).
4. **Economic models**, such as internal rate of return (IRR), net present value (NPV), return on investment (ROI), cost-benefit analysis, and option pricing theory;
5. **Decision analysis**, including multi-attribute utility theory (MAUT), decision trees, risk analysis, and the analytic hierarchy process (AHP).
6. **Interactive methods**, such as Delphi, Q-sort, behavioral decision aids (BDA), and decentralized hierarchical modeling (DHM).
7. **Artificial intelligence (AI)**, including expert systems and fuzzy sets;
8. **Portfolio optimization**.

4. Methods and Procedure

The AHP is one of the most widely used to solve multiple criteria decision-making problem in both academic research and in industrial practice. In addition, AHP has been commonly used industry and aid in concept selection/evaluation in the NPD

process [5][6].

The methodology based on the AHP approach and scoring techniques is devised in this study. Firstly, the definitions of constraints are illustrated in detail. Then, the technology evaluation mechanism is constructed and the following procedure is particularly explained in the next section.

4.1 Constraints and assumptions

The constraints and assumptions within the study are organized as follows:

1. This study focuses on the new product development (NPD) area.
2. The set of criteria can applied to any other type technology in the NPD area.
3. The criteria within each level are independent in this problem.
4. The weight with respect to each criterion is judged based on the specific type of technology.

4.2 Technology evaluation mechanism

The proposed mechanism is a composite model which consists of two established selection techniques including the AHP approach and the scoring technique. The AHP approach is incorporated into the mechanism, as constructs AHP hierarchy, and determines the weights of criteria. The Scoring technique is utilized to evaluate the technology. The technology evaluation mechanism is depicted in Figure 4.1 [7][8][9].

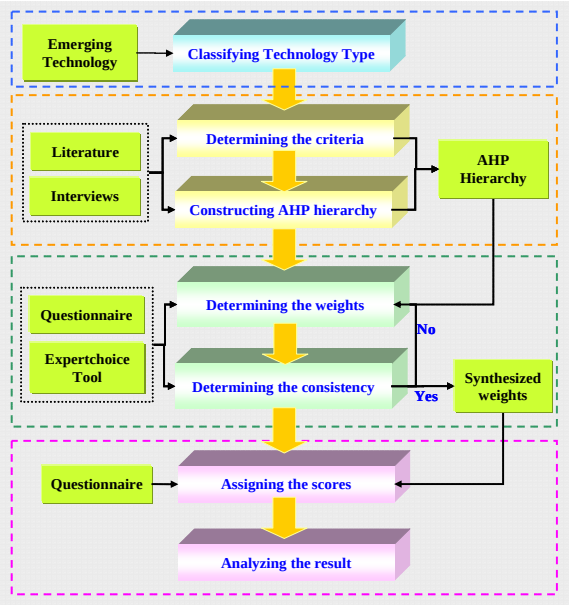

Figure 4.1 The technology evaluation mechanism

And, the main procedure is illustrated in the follows:

1. Classifying Technology Type based on six classifications proposed.
2. Constructing AHP hierarchy.
3. Determining the weights and the consistency.

Setp1: Determining pair-wise comparison.

Step 2: Converting comparison data to comparison matrix.

Step3: Using eigenvector to calculate each comparison matrix weight.

Step 4: Check the consistency of each comparison matrix.

Step 5: Using weighted geometric mean to combine group judgments.

4. Assigning the scores.

5. Empirical Study

5.1 Classifying technology types

The CNT-BLUs are considered as emerging and promising technologies, especially for continuing competitiveness of

Taiwanese FPD industry. This study sets CNT-BLUs as subjects to be evaluated. It is classified as new to company technology which is denoted as a new technology applied in existing market.

5.2 Building Hierarchy Structure

The AHP hierarchy is structured based on literature and practice with respect to four key components including the specific goal, primary dimensions, secondary criteria, and the following sub-criteria. Accordingly, the goal is identified as evaluating the technology. Once the goal placed, the topmost element is decomposed into subcomponents and attributes. Then, four primary dimensions that are identified as the most important: (1) Technological, (2) Marketing, (3) Financial, (4) Manufacturing. Furthermore, each of these primary criteria, in turn, is assessed in term of two secondary. For example, Technological dimension is decomposed into both criteria of technological Competitiveness (TCP), and Technological Connection (TC). Under each of secondary criteria are sub-criteria which are utilized to evaluate new technology directly (As shown in Figure 5.1).

5.3 Determining Criteria Weights

After constructing AHP hierarchical structure, and the followed by determining each criterion weight, the result of synthesized weights is shown in Figure 4.7.

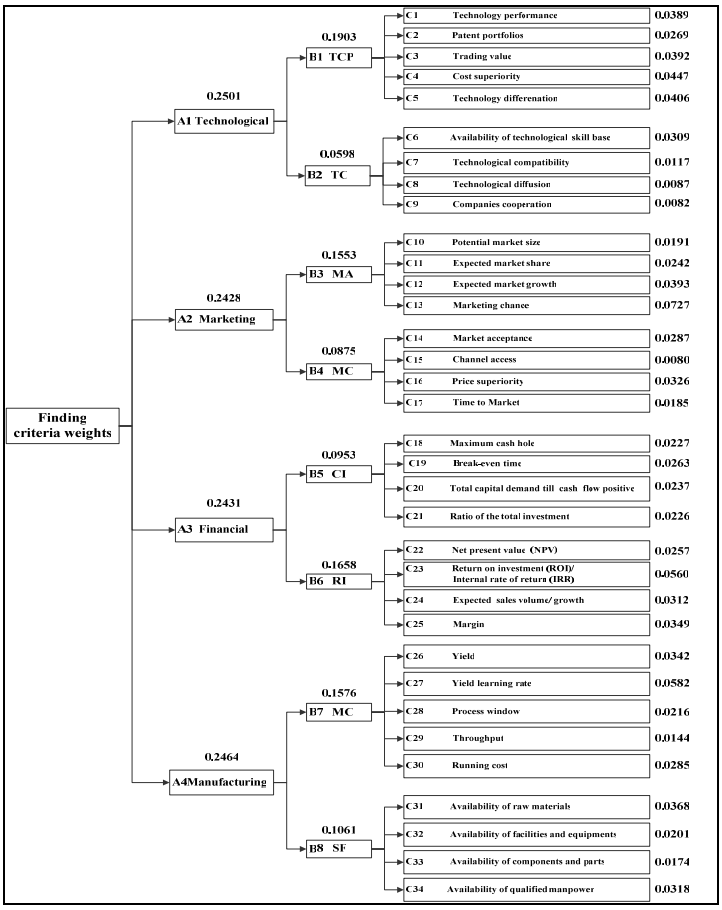

Figure 5.1 The AHP hierarchical structure with synthesized weights

5.4 Assigning the scores

The scoring model is arranged to assign rating to each technology with respected to each sub-criterion based on individual subjectivity. Here 11 experts from research institution, market survey institute, and industrial field are asked to give rating score for specific technology using designed questionnaire.

According to the result of synthesized scores shown in Table 5.1, the CNT-BLU has the highest synthesized score (49.3439), the followed by LCD (46.989) which is a successful existing technology. In comparison with these scores, it means that CNT-BLU is may be an option for Taiwanese FPD industry.

Table 5.1 Synthesized score

Technology / Participants	LCD	CNT-BLU
P1	3.7518	4.6658
P2	3.7443	5.1464
P3	4.3505	3.8286
P4	3.6792	3.877
P5	4.2399	4.224
P6	4.6536	4.4454
P7	4.3454	3.8199
P8	4.8031	4.71
P9	4.8246	5.3618
P10	4.3161	4.4925
P11	4.2805	4.7725
Synthesized score(S_{aj})	46.989	49.3439
Average score ($\overline{S_a}$)	4.2717	4.4858

Study 1:

Furthermore, the statistic analysis is applied to identify whether the samples appear very different or compare the distribution of scores? The Freidman two-way Analysis of Variance by Ranks is utilized in this study.

Here are null and alternative hypothesis:

H_0: Three technologies have the same distribution of scores.

H_1: Three technologies don't have the same distribution of scores.

The result is

$$F = 1.636 < \chi^2(N = 11, k = 3, \alpha = 0.01) = 8.91$$

So, not reject H_0

The result of hypothesis is revealed that both technologies belong to the same cluster, because we can not reject H_0.

6. Conclusion

In comparisons with previous study in this area, the main conclusions from this study can be drawn and itemized as follows:

1. This study devises a feasible and systematical mechanism based on AHP and scoring techniques to deal with the technology evaluation. Moreover, many factors with respected to technology evaluation are arranged and considered from structured review of the previous literature.
2. This study provides more complete evaluative criteria especially bring manufacturing dimension into evaluative consideration. According to the results, it is revealed that manufacturing dimension is considered as essential as others for managers to evaluate technology. In addition, manufacturing dimension (0.264) has the highest relative importance; followed by Technological (0.2501).

3. The study implements proposed evaluation mechanisms to new promising technology CNT-BLUs. According to the result, CNT-BLUs may be a good option for Taiwanese FPD industry.

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