《清雲學報》第三十二卷　第一期

～～目　　錄～～

電資類

工程類

商管類

人文社會類

附錄

本期論文審查通過率爲 25%

學報序

逢此跨年時刻，嚴寒之氣籠罩大地，幸有諸位編輯委員的鼎力協助，第三十二卷第一期的《清雲學報》已順利完成編輯、校對作業，即將在一月中旬出刊。感謝所有投稿者及審查委員的支持與鼓勵，因為每一期的學報，皆集眾力所成，方得問世，在此，祝賀清雲全校師生新年快樂，也期許《清雲學報》在未來2012年能質量並進，更上一層樓。

本期共收六篇審查通過的論文，其中電資類一篇、工程類一篇、商管類三篇、人文社會類一篇，今大略說明如下：

電資類部份為葉官俤老師等四位作者的〈設計一組以共平面波導饋入且具DGS希爾伯特槽孔螺繞線之諧振器俾供應用於無線區域網路雙頻系統〉一文，在電路構型及小型化的研究上「具有創意」；其次工程類則為李國樑老師的〈以六標準差改善營造業流程噴漿作業之研究〉一文，結論「有利於證明六標準差管理應用於營建業的成效與結果」，對於實際作業，貢獻頗大；再則商管類三篇依次為方正璽等三位老師的〈網路負面口碑之探索性分析〉、李水彬等三位老師的〈以LASSO選模探討影響學生滿意度的重要服務品質構面〉、鄭敏聰老師的〈機構投資人從事期貨交易之影響－台灣之實例〉等，審查委員針對此三篇論文評語，多肯定為重要議題且為「具創新性」的討論；人文社會類則為校外稿，來自耕莘健康管理專科學校黃郁修老師的〈論孫權的戰守策略—以「爭荊州」為例〉一文，除評為「文筆通順」外，亦兼具「學術性與可讀性」的優點。

本期學報，共收二十四篇稿件，其中校內稿13篇，校外稿11篇，論文通過審查率為25%。經過學報編輯委員會數年努力耕耘下，校外投稿不斷增加，顯見《清雲學報》亦逐漸建立屬於自己的舞台，於此2012年的開始，期許《清雲學報》日漸茁壯，也期待更多專家學者共同澆灌此一屬於我們清雲的學術園地！

清雲學報編輯委員會　謹識

中華民國一〇一年一月

設計一組以共平面波導饋入且具DGS希爾伯特槽孔螺繞線之諧振器俾供應用於無線區域網路雙頻系統

Design a CPW-fed Hilbert Slot Spiral Resonator in DGS for WLAN Dual-band Systems

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摘　要

本文設計一組以共平面波導饋入與 DGS 希爾伯特槽孔螺繞線之諧振器以作為帶通濾波器。它是經由三組不同結構的共平面波導饋入與具螺繞線之諧振器，評比所得之濾波器。此一濾波器，在 2.4/5.8GHz 兩個頻段，具有低介入損耗(0.81/0.87dB)、高抑制位準(38.22/42.74dB)、寬頻寬(22.8%/36.3%)等響應特性。這個共平面波導饋入與螺繞線之諧振器，它的背面加有十字線結構，可應用於無線區域網路雙頻系統。同時，將雙頻濾波器的設計步驟呈現出來。此一濾波器，在模擬與實驗所獲得之響應特性是一致的。

關鍵詞：雙頻段、共平面波導饋入、希爾伯特曲線

Abstract

This paper proposes the CPW-fed spiral resonators with Hilbert slot configuration in defect ground structure (DGS) for a bandpass filter (BPF). For comparison, three CPW-fed spiral filters are fabricated and measured. To obtain low insertion loss (–0.81dB/–0.87dB), high out-of-band rejection level (–38.22dB/–42.74dB) and wider bandwidth (22.8%/36.3%) of 2.4/5.8GHz frequency responses, the CPW-fed slot spiral resonators with cross line are applied for WLAN dual-band systems. The design procedure for dual-band filter is presented. The proposed filter is successfully simulated and measured to obtain the agreeable frequency responses.

Keywords**:** Dual-bands, CPW-fed, Hilbert-curve

Ⅰ. INTRODUCTION

The attractive features of the spiral resonator are its compact size, low cost, high Q, and low radiation loss. These characteristics are usually applied to realize band-pass filters in microstrip circuits and superconducting coplanar circuits. The filters have wide applications in satellite communication, mobile communication, wireless telecommunication, and microwave system. In practice, cross-coupled spiral resonators can be used to obtain higher selectivity without using more resonators. Recently, the superconducting cross-coupled spiral resonators have been realized in coplanar structures [1–6, 17] with CPW-fed DGS way [13, 14, 19–21] and parallel coupled line [16] and cross shaped line [18]. However, the shape of the spiral has to be considerably modified to achieve larger coupling coefficient for improving the performance.

Recently, new meander lines for microstrip line structure with Hilbert configuration have been proposed. It implies that by infinite iterations the Hilbert configuration presents a property of infinite, although the entire curve fits into the finite area. This effect of space-filling can be exploited for the miniaturization for microstrip antenna [8–12, 22] resonator and filter [7, 15].

The increasing demand for multi-band applications has required a single wireless transceiver to support multi-band operations. The dual-band BPF plays an important role in a multi-band transceiver [23-32]. For 2.4 and 5.2 GHz dual-band systems, using a coupled-serial-shunted (SIR) line structure was used and designed [23]. The parallel-coupled and vertical-stacked SIR configurations were used at 2.45/5.2 GHz or 2.45/5.8 GHz dual-band [24]. The compact ring dual-mode resonator with 2.4/5.2 GHz dual-band was proposed [25]. The dual-mode ring resonator with periodically-loaded open stubs was presented with 2.4/5.8 GHz dual-band [29]. However, the WLAN systems combining 2.4, 5.2, and 5.8 GHz are becoming more attractive. Especially for universal applications, it should be covering the whole 2.4-2.5 GHz and 5.15-5.85 GHz bands for the WLAN systems. Thus, a dual-band and wideband filter is a key component for the WLAN systems.

The spiral resonator in DGS with Hilbert slot configuration introduced for a large coupling coefficient will first be described in this paper. For comparison, conventional CPW-fed spiral resonator in DGS with parallel line, CPW-fed Hilbert slot spiral resonator in DGS with parallel line and CPW-fed Hilbert slot spiral resonator in DGS with cross line are studied. To obtain low insertion loss, a high out-of-band rejection level and a wider bandwidth of the resonators are proposed and analyzed. The dual-band design procedure is also proposed. Simulation results including surface current distributions and frequency responses are presented and discussed.

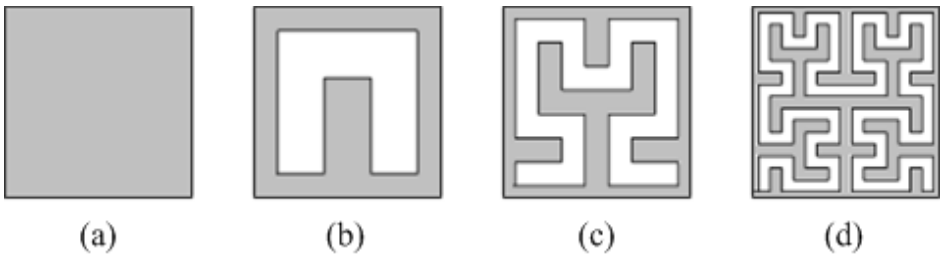


Figure 1. Hilbert slot iteration configurations. (a) Original, (b) 1st, (c) 2nd, (d) 3rd iteration.

Ⅱ. FILTER DESIGN AND BASIS

2.1 Iterative Hilbert Slot Curve Configurations

The Hilbert fractal curve [21] is known as the space-filling curve. The structure of this shape can be made of a long metallic wire compacted within a microstrip patch. As the iteration order of the curve increases, the Hilbert fractal curve may fill the space of the patch. It has been used in small antenna design. The Hilbert fractal slot curve generated in an original patch is shown in Figure 1(a) with the first three iterations in Figure 1(b)–(d).

2.2 Design Procedure

For deterministic design and better performance, a design procedure for dual-band application is presented in this paper. For analytical approach, f_1 represents the resonant frequency of the first band (BW_1), which is related to the total length of spiral and the feed lines, and f_2 depicts the resonated frequency of the second band (BW_2), which is determined by the total length of parallel line. Then, the design procedure is stated as:

[a] The guided wavelength (λ_{g1}) of the resonated frequency f_1 is calculated.

[b] The value of $\frac{\lambda_{g1}}{2}$ determines the total length of spiral and the feed lines.

[c] By $\frac{\lambda_{g1}}{2}$, the total length of Hilbert slot spiral and the feed lines is decided.

[d] The guided wavelength (λ_{g2}) of the resonated frequency f_2 is computed.

[e] Using $\frac{\lambda_{g2}}{2}$, the total length of parallel line is determined.

[f] By $\frac{\lambda_{g2}}{2}$, the total length of cross line is decided.

[g] The certain resonated frequency can be achieved by tuning.

2.3 CPW Spiral Resonator DGS / Parallel Line

For comparison, a CPW-fed spiral resonator with parallel line on top is presented in Figure 2(a) and (b). The dimensions are: a = 3.30 mm, L_1 = 10.0 mm, L_2 = 5.0 mm, W_1 = 0.12

mm, W_2 = 0.45 mm, W_3 = 0.60 mm, W_4 = 0.12 mm, S = 0.20 mm, W = 1.20 mm, g = 0.25 mm, d_1 = 1.0 mm, and d_2 = 1.0 mm.

2.4 CPW Hilbert Slot Spiral Resonator DGS / Parallel Line

With the 2nd iteration Hilbert configuration, the CPW-fed Hilbert slot spiral resonator with parallel line is proposed in Figure 3(a) and (b). The dimensions are: a = 4.20 mm, L_1 = 10.0 mm, L_2 = 5.0 mm, W_1 = 1.56 mm, W_2 = 0.12 mm, W_3 = 0.60 mm, W_4 = 1.08 mm, S = 0.20 mm, W = 1.20 mm, g = 0.25 mm, d_1 = 1.0 mm, and d_2 = 1.0 mm.

2.5. CPW Hilbert Slot Spiral Resonators with DGS Size Variation

In Figure 4(a) and (b), the variations of CPW-fed Hilbert slot spiral resonators include the size of Hilbert spiral in DGS and the cross line in top. The size dimensions are: 4.20 × 4.20 mm^2, 3.29 × 3.29 mm^2, and 2.80 × 2.80 mm^2, with the constant L_1 = 9.0 mm and / L_2 = 9.4 mm.

2.6. CPW Hilbert Slot Spiral Resonator with Cross Line Length variation

In Figure 4(a) and (b), the cross line dimensions are: L_1 = 9.0 mm / L_2 = 10.0 mm, L_1 = 9.0 mm / L_2 = 9.40 mm, and L_1 = 9.0 mm / L_2 = 8.80 mm, with the constant 3.29 × 3.29 mm^2.

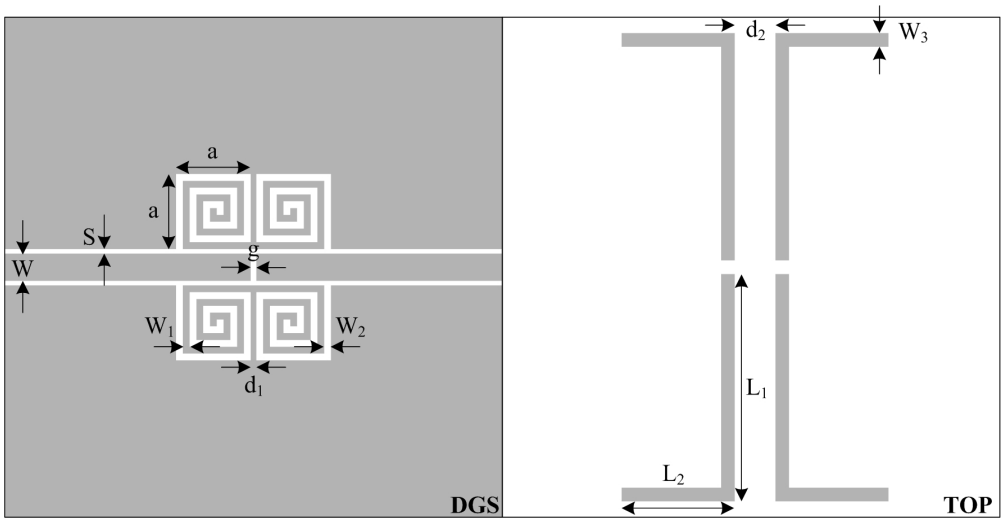


Figure 2. CPW-fed spiral resonator filter. (a) Spiral resonators in DGS, (b) Parallel lines on top

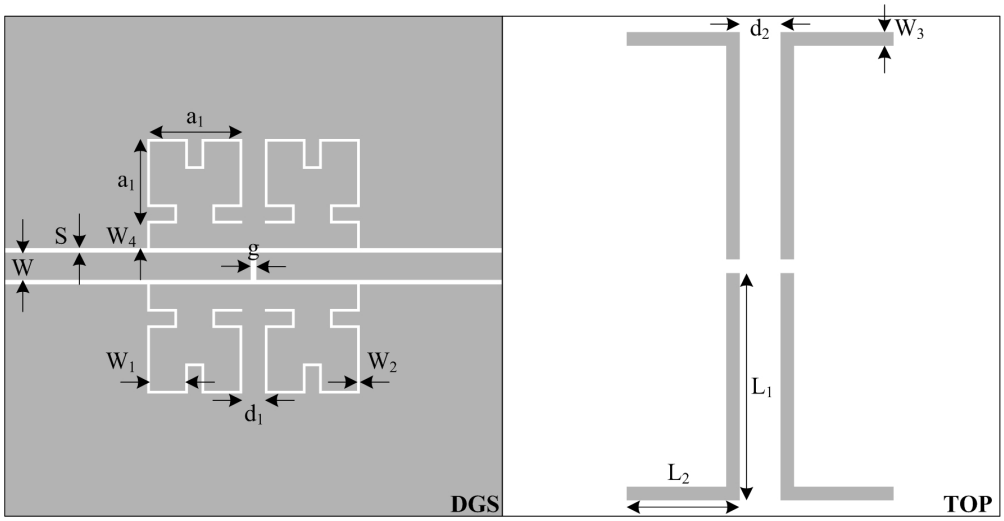


Figure 3. CPW-fed Hilbert slot spiral resonator filter. (a) Hilbert resonators in DGS, (b) Parallel lines on top.

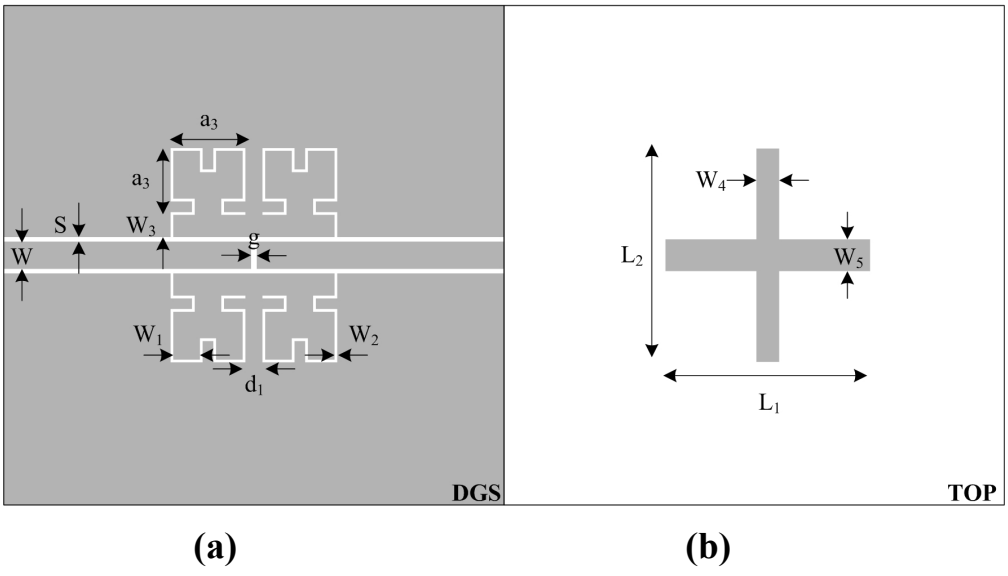


Figure 4. CPW-fed Hilbert slot spiral resonator filter. (a) Hilbert resonators in DGS, (b) Cross lines on top.

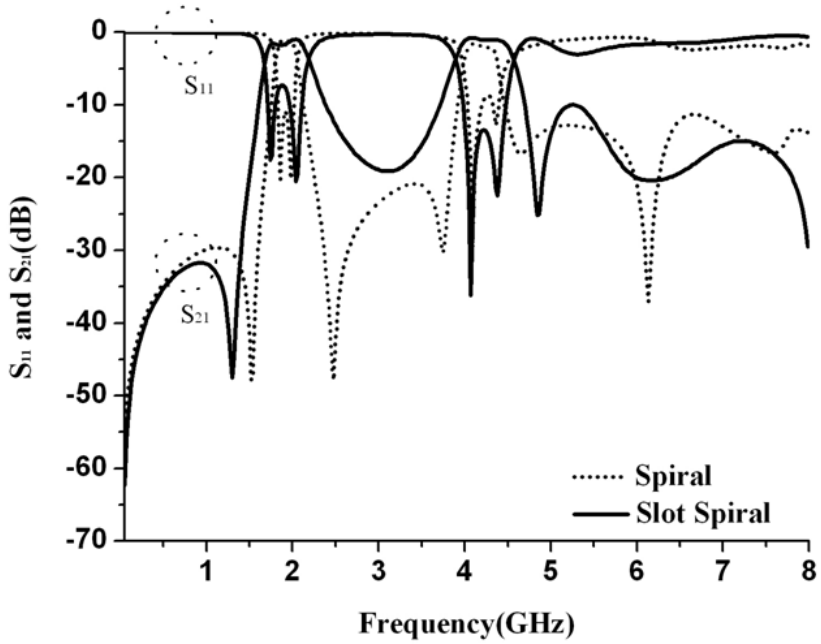


Figure 5. Simulated frequency responses of spiral and slot spiral resonators with parallel lines.

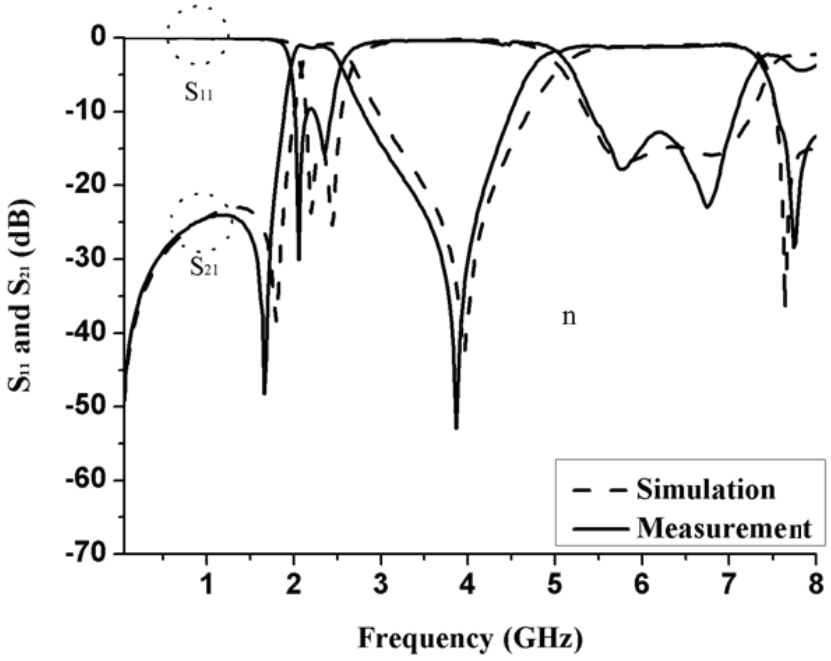


Figure 6. Frequency responses of slot spiral resonators with cross line.

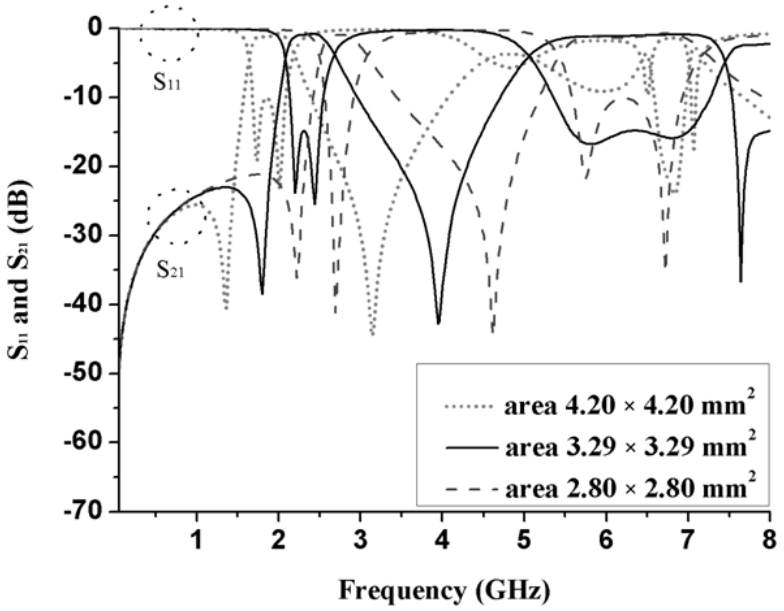


Figure 7. Simulated frequency responses of size variations (L_1 = 9.00 mm & L_2 = 9.40 mm)

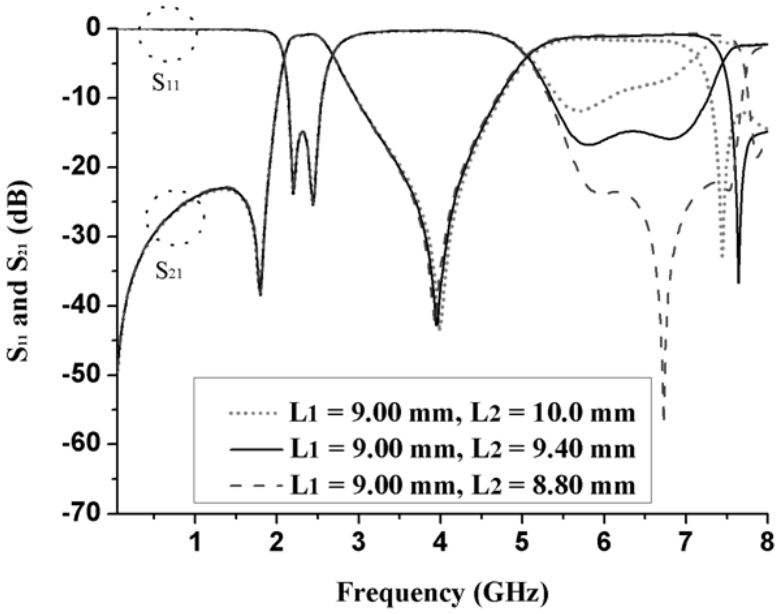


Figure 8. Simulated frequency responses of cross line variations (3.29 × 3.29 mm^2)

Ⅲ. SIMULATION AND RESULTS

The simulations for CPW-fed spiral and Hilbert slot spiral are achieved with the aid of CAD IE3D [33]. The RT/duriod-6010LM substrate with dielectric constant ε_r = 10.2, δ =

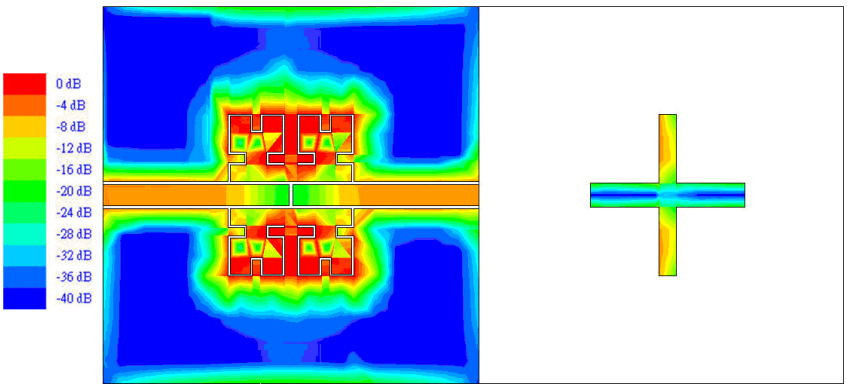
0.0023, thickness h = 1.27 mm is used. For the requirement of 50 Ω impedance, the width of strip is 1.2 mm, length of feed-line is 10.87 mm, effective dielectric constant ε_{reff} = 5.70 and guided wavelength λ_g = 53.2/20.36 mm at frequency f_0 = 2.36/6.17GHz.

3.1 S-parameters Frequency Responses

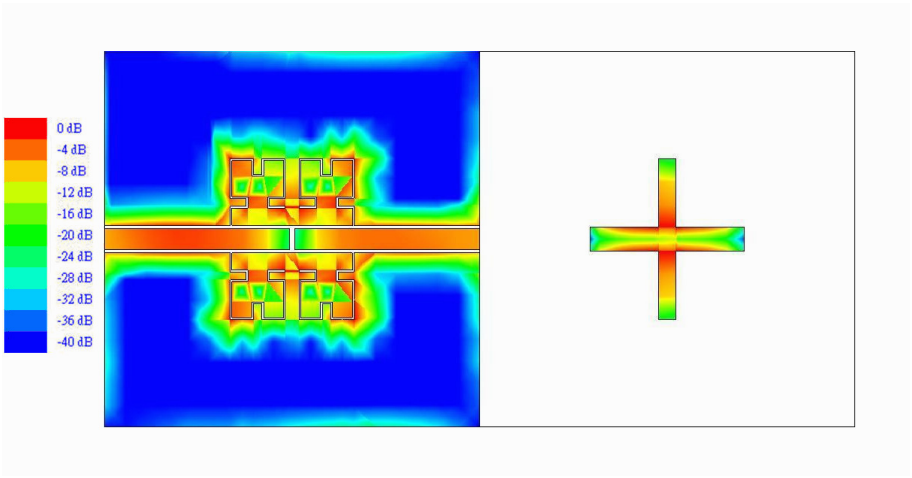
For comparison, the simulated frequency responses of CPW-fed spiral resonator with parallel line and Hibert slot spiral resonator with parallel line are shown in Figure 5. The results indicate that both resonators exhibit dual-band responses, but the slot spiral resonator with parallel line expresses wider bandwidth. The double dips existed in S_{11} and the ripple expressed in S_{21} is the drawback. Then, the slot spiral resonator with cross line is thus designed, and both simulated and measured frequency responses are shown in Figure 6, which has a good agreement. For the identical size and width of spiral, the slot spiral resonators with cross line exhibits more wide-band. Finally, the simulated frequency responses related to size variations with the identical L_1 = 9.0 mm / L_2 = 9.40 mm are presented in Figure 7. The resonator with more area obtains better dual-band response. By changing BW_2, the simulated frequency responses related to cross line variations with the identical 3.29 × 3.29 mm^2 are presented in Figure 8. All the results of frequency responses of the filters are listed in Table I for comparison and analysis purposes.

3.2 Surface Current Distributions

For the CPW Hilbert slot spiral resonator with cross line, Figure 9 presents the surface current distributions simulated by IE3D. Obviously, more coupled magnitudes (red) in Hilbert slot spiral and light magnitudes (yellow vertical line) in cross line are observed for BW_1 in Figure 9(a). In addition, the high current intensity in Hilbert slot spiral and more coupled magnitudes (red) in cross line for BW_2 are shown in Figure 9(b). Thus, the behavior demonstrates the Hilbert slot spiral is related the BW_1 and the cross line is determined the BW_2. Photography of the CPW-fed Hilbert slot spiral resonator is presented in Figure 10.



(a)



(b)

Figure 9. Current distributions for CPW-fed Hilbert slot spiral resonator with cross line.

(a) at BW_1, (b) at BW_2.

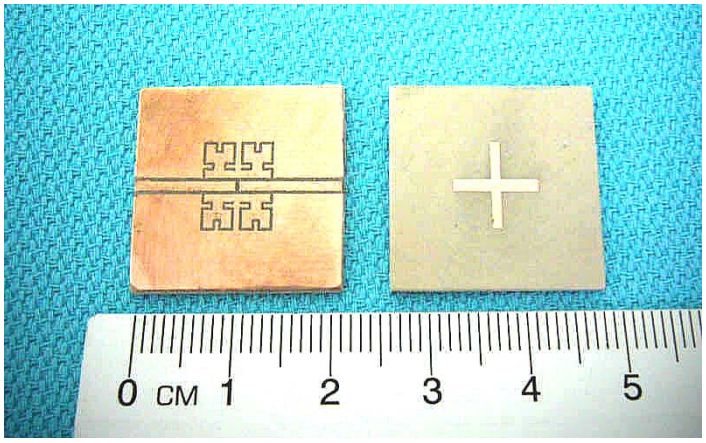


Figure 10. Photography

Ⅳ. Conclusions

Three CPW-fed spiral resonators with typical spiral and two Hilbert slot spiral configurations are presented for a large coupling coefficient in this paper. The low insertion loss (–0.81dB/–0.87dB), high out-of-band rejection level (–38.22dB/–42.74dB), and wider band width (22.8%/36.3%) at 2.4/5.8GHz frequency responses of CPW-fed Hilbert slot spiral resonators with cross line are presented.

The simulated results depicted the identical surface current distributions among slot spiral resonator and cross line are enhanced. The compact CPW-fed Hilbert slot spiral filter and the design procedure can achieve good performance for WLAN dual-band applications. For compact dual-band design, the proposed filter covers the required bandwidths for WLAN bands (2.09-2.63 GHz and 5.05-7.89 GHz). The coupling way is constructed in coplanar and

efficient. The structure is smaller in size with 22×22 mm^2.

TABLE 1. FREQUENCY RESPONSES RESULTS

	spiral and parallel line (BW_1/ BW_2)	**slot spiral and parallel line (BW_1/ BW_2)**	**slot spiral and cross line (BW_1/ BW_2)**
f_0 (GHz)	1.92/4.18	1.90/4.20	2.36/6.17
BW (GHz)	0.23/0.35	0.47/0.64	0.54/2.24
FBW (%)	12/8	24/15	22.8/36.3
insertion loss (dB)	-1.19/-1.55	-0.94/-0.70	-0.81/ -0.87
rejection (dB)	(-47.67/-30.27)/ (-46.99/-16.74)	(-47.45/-19.12)/ (-19.12/-25.18)	(-38.22/-42.74)/ (-42.74/-36.03)
line width (mm)	0.12	0.12	0.12

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以六標準差改善營造業流程噴漿作業之研究

Cement Mortar Spraying Process Quality Improvement by Six Sigma Methodology

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摘　要

本研究是以個案研究的方式展現六標準差管理針對營造業噴漿流程進行改善。依照六標準差管理 DMAIC(Define-Measure-Analyze-Improve-Control)的方法論，本研究之步驟，首先將問題清楚定義，接著再利用六標準差管理的工具－流程圖展開找出噴漿作業的輸入及輸出變數，並透過因果矩陣圖來找出關鍵輸入因素。再利用統計方法，例如：變異數分析(ANOVA) 和 Fisher's LSD 檢定來驗證真正影響的因素為何及利用失效模式分析進行改善以防止關鍵輸入變數失效。最後則是透過施工過程的重新規範，如：訂定明確的噴嘴仰角操作規劃且設定抽查的機制，讓員工在操作不易發生錯誤，除此之外，藉由管制計畫來有效的管控水泥攪拌的均勻度、噴頭的清洗頻率、水泥與砂配合比例等關鍵變數以降低各關鍵因素發生錯誤的頻率。本研究專案小組透過六標準差管理的討論機制發展出新的改善方法，成功的降低不良發生率，同時也驗證了六標準差品質改善手法確實提供了本研究實質之效益。

關鍵詞：六標準差、噴漿作業、個案分析、品質改善、營建業

Abstract

This research demonstrated a cement mortar spraying process quality improvement project using Six Sigma methodology. Based on the Six Sigma DMAIC approach, the quality problem was defined at first. Secondly, the input and output variables are explored by Six Sigma tools. Thirdly, statistical tools, such as ANOVA and Fisher's Least Significant Difference (LSD) Test, were used to validate what the key point input variables (KPIVs) are and Failure Mode and Effect Analysis was used to improve the process. Finally, the control method was utilized control key point input variables such as nozzle elevation, cement mixing uniformity, frequency of nozzle cleaning and the proportion of cement and sand in order to avoiding variation happened again in process. The quality improvement team succeeded reducing cement mortar spraying process defective yield in this case. The result of studies proved that the Six Sigma methodology is feasible and efficiency to implement on construction engineering quality improvement. It is worthy of introducing this methodology into the construction engineering fields.

Keywords**:** Six Sigma, cement mortar spraying process, case study, quality improvement, construction industry

壹、研究動機及目的

在台灣的建築物在完成之後幾乎都會進行裝修的工程，例如：貼磁磚或是粉刷油漆。而在此工程中噴漿作業爲其中主要的工法。噴漿作業的施作流程，乃在結構體灌漿完畢完成拆模之後，將水泥、粗細粒料、水與附加劑拌合後，以噴泵機具藉壓縮空氣經由管路及特殊噴嘴均勻噴佈於施工面之作業。噴漿作業對於裝修粉刷工程而言，若是出現品質問題，對於下個施工作業會有很大的影響，如：磁磚脫落、牆面不平、或是牆面龜裂等問題發生。如此的品質問題常常會引來顧客的抱怨。本研究採用個案研究的方法展現以六標準差管理針對噴漿作業進行改善。六標準差管理是於1980年在Motorola被發展出來，在品質改善的方法論中屬於較新一代的改善手法。六標準差管理最早被應用在製造業，後來服務業中的金融服務業、保險業、物流業、甚至醫療服務業等都相繼引用導入。而在文獻中發現應用營建業六標準差管理案例不是很多，因此本研究的研究結果可以給台灣營建業在品質管理上一個參考的範例。本研究依照六標準差管理的方法論DMAIC(Define-Measure-Analyze-Improve-Control)的實施步驟，先將問題定義，利用六標準差品質改善手法之流程圖展開呈現噴漿作業的所有輸入及輸出變數，並透過因果矩陣圖來找出關鍵輸入因素，再利用統計方法進行因素驗證及失效模式分析找出各關鍵輸入因素引發之真因，最後則是透過管制計畫來有效的管控及降低各關鍵輸入因素發生變異的機會達到持續品質改善的目的。

貳、六標準差管理及其重要工具

一、六標準差管理

六標準差管理是近代發展品質管理方法之一，在 1980 年的 Motorola 被發展之後，已經有非常多的公司，如：Texas Instruments、Allied Signal(or Honeywell)、Kodak、General Electric、Sony、FedEx、Home Depot and Wal-Mart 等知名企業紛紛導入，獲得相當不錯的成果(Antony and Banuelas, 2002；Patton, 2005)。六標準差管理是以統計學的概念來衡量流程中的瑕疵或是不良的發生，將流程中所發生的錯誤、失敗或是不良品的發生機率控制在百萬分之三點四的水準(Kumar and Gupta, 1993)，也就是以追求極小的誤差爲目標，並持續推動管理改革的活動，達到六標準差的目標，換句話說，表示品質已經近乎完美的境界。對於六標準差，有許多學者都爲它下了不同的定義。六標準差的創始者之一 Mikel Harry(1998)認爲：「六標準差是利用一連串統計的方法解決在流程上的變異使得在品質上有突破性的改進與獲得實際上利益，進而讓產品或者是服務上可以持續良好的品質」。Montgomery 和 Woodall(2008)認爲六標準差是專案導向及統計爲基礎的方法論，此方法可以消除產品、流程中的變異、錯誤以及浪費。國內學者蘇朝墩等(2008)認爲六標準差簡單的說就是消除浪費和在流程中建立防錯的機制，並且爲顧客創造價值。

企業要如何的成功導入六標準差管理？根據文獻的整理，包括了以下幾點因素：1. 高階主管的支持與參與；2.統計工具的教育訓練及使用；3. 企業充分的準備；4. 訓練專業人員；5. 與企業策略及顧客相連結；6.與人力資源及供應商相連結；7.專案管理的技巧及適當的專案選擇等(Henderson and Evans, 2000；Banuelas and Antony, 2002)。其中提

到必須要靠一群受過訓練人員，這群人員在六標準差的組織中有特別的名稱，如：盟主(Champion)、大黑帶(Master Black Belt)、黑帶(Belt Belt)和綠帶(Green Belt)等。藉由這群專業人員的通力合作才能順利且成功的完成改善專案(Montgomery, 2010)。

六標準差的黑帶專案的執行通常都是以定義(Define)、量測(Measure)、分析(Analyze)、改善(Improve)以及控制(Control)五個階段進行，簡稱 DMAIC 模式。DMAIC 模式是個結構性的問題解決的方法論(Montgomery, 2010)，它是個持續循環的封閉迴圈，利用此迴圈消除沒有效益的流程步驟，並且常常會再專注需要改善的地方進行持續改善(Kwak and Anbari, 2006)。根據 Pande(2000)等的論述，這五個階段所代表的意義就是 Define：確認問題點、顧客需求並且形成專案及設定專案目標、Measure：收集流程輸入及輸入的資料、Analyze：建立假設、驗證因素探尋少數重要造成問題的真因、Improve：消除變異改善製程、Control：建立流程的關鍵變數控制。其中 A 及 I 的階段利用統計的方法，如：實驗設計法或是統計假設檢定來驗證因素。統計方法的使用可以讓製程變異的真因現形，如此才能真正的解決製程的問題。

二、失效模式分析

1950 年，美國格魯曼(Grumman)飛機公司首先提出失效模式與效應分析(FMEA)的方法，爲了要改善飛機主操縱系統，並增加電器裝置與油壓裝置之可靠度(吳貴彬與陳相如，2003)。美國太空總署(NASA)於 60 年代執行阿波羅計畫的過程中，也採用失效模式分析提升太空計劃中所有零件、系統的可靠度並且要求契約對象要嚴格執行。由於太空開發計畫中使用失效模式分析的成果相當卓著，使得許多工業界也開始重視這個工具，汽車業就是一個有名的例子。1977 年福特汽車成功地使用失效模式分析與產品設計及製程管理，找出設計及製程的潛在問題。之後美國三大汽車公司「福特(Ford)」、「克萊斯勒(Chrysler)」、「通用(General Motor)」在美國品質學會(ASQC)與汽車互助團(Automotive Industry Action Group，AIAG)的贊助之下整合各汽車之規定與表格，完成「潛在失效模式與效應分析參考手冊」，統一當時 FMEA 在汽車工業所用的作業程序及表格。而三大汽車廠於 1994 年 8 月首版發行品質體系要求（Quality System Requirements）即爲 QS9000 品質保證系統，將失效模式分析列爲其中必備的分析工具。之後國際的各大車廠組成 IATF (國際汽車行業工作組)將 ISO 9001:2000、AVSQ (義大利)、EAQF(法國)、QS-9000 (美國)和 VDA6.1(德國)等標準要求爲基礎共同創立 TS 16949 的全球汽車品質標準，當然失效模式分析依舊成爲一個重要的工具之一。另外，在醫學實驗室管理方面，國際標準組織 ISO/TC 212 技術委員會於 2008 年通過 ISO/TS 22367 並以失效模式分析當作預測性風險分析改善的工具。由以上其演進的歷史可知，失效模式分析對於工業界是相當重要的工具之一。什麼是失效模式分析？FMEA 是一個可以在發生前即可辨識潛在失敗模式的系統性分析技術，目的在偵測可能導致意外或嚴重事件之風險有多高(Narayanagounder and Gurusami, 2009)。失效模式分析原本就是個獨立的工具，而六標準差管理將此工具納入並且擔任改善及降低流程變異風險的重要工具之一，對於六標準差管理的改善效益上著實具有顯著的功能。

三、因果矩陣

因果矩陣工具的目的是找出優先改善的地方在哪裡(Johnson et al., 2004)，進一步的說明就是六標準差的專案小組可以利用因果矩陣當作輸入因素的篩選決策工具，而因果矩陣

通常在六標準差管理 DMAIC 模式中的 M 階段被使用。因果矩陣通常會利用 Excel 軟體來建立一個表，而表可以分爲四個部分，其中表的上方會放進關鍵輸出變數(KPOV)，專案小組會依照顧客的需求給予每個關鍵輸入變數一個權數，而權數會依照對於顧客重要的程度給予 1-10 的分數，分數越高代表顧客對於該關鍵輸入變數越看重。在表的左方會放入許多個由流程展開獲得的輸入變數，而在關鍵輸出變數與輸入變數之中會建立一個矩陣，而專案小組會利用討論的方式給予關聯性的分數，分別是 0，1，3，9。其中 0 代表沒有相關，1 代表低度相關，3 代表中度相關，而 9 代表高度相關。當專案小組將分數都決定之後，Excel 將會關鍵輸入變數的權數與關聯性的分數計算乘積和，最後可以依照分數的高低排序之後，高分的輸入變數及代表對於造成關鍵輸入變數變異有高度影響，亦可稱高分的一群因素爲關鍵數入變數(KPIV)。

本研究是以個案分析的方式來呈現六標準差的方法論，本研究專案的執行過程包括了：

第一，問題描述：敘述個案公司在噴漿過程所遇到的品質問題。
第二，因素探索：利用流程展開及因果矩陣的工具進行因素探索。
第三，因素驗證：利用統計工具進行因素的驗證。
第四，關鍵因素控制：利用管制計畫將關鍵入變數進行監控，防止變異再度發生。
第五，研究發現與結論：敘述個案的發現以及對於此案例對於營建業品質管理的貢獻。

研究流程圖，如圖 1 所示。

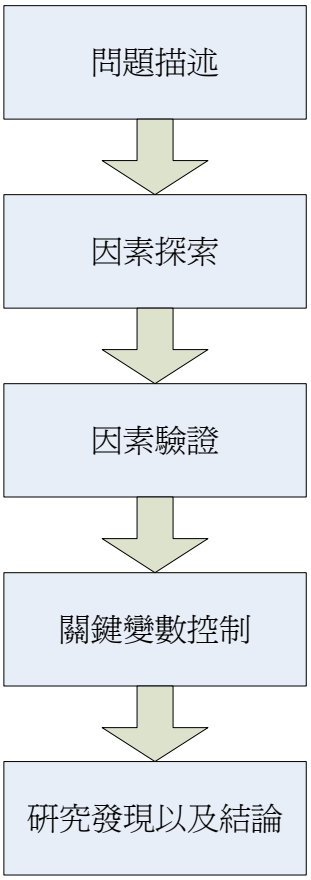

圖 1 研究流程圖

參、個案分析 － 噴漿作業改善專案

一、公司背景及問題描述

案例公司位於台灣北部，主要業務承攬範圍涵蓋私人與公共工程，包括辦公大樓、大小型集合住宅、別墅、廠房、醫院及學校等，業績遍佈全台灣。累積多年豐富且完整的施工經驗，自規劃階段的圖說檢討、施工計劃到發包計劃，施工階段的標準化施工圖、樣品試作到製程品管，完工驗收階段的工程防護、完工驗收到點交，修繕服務、經驗回饋到提案改善，所有的品質管理流程均落實改善制度，以符合顧客對品質的要求。

本個案的研究範圍爲噴漿作業之流程。由於個案公司發現噴漿作業流程存在品質問題，而此問題可能會造成了後端工程的磁磚脫落、牆面龜裂、牆面不平整等問題，除了後端工程人員經常抱怨之外，有時也會接到客訴。因此公司決定組成六標準差專案小組針對噴漿作業流程進行改善。六標準差專案小組的成員包括營造廠經理(黑帶)及流程操作員 3 人。噴漿作業流程如下：結構體灌漿完成拆模後，先進行粉光面檢查，清除牆面的突出物或是殘餘模板，其後進行拉水平線、灰誌製作、樑及柱 V 型基準灰灰誌、牆灰誌等工作，以作爲控制粉刷厚度及粉刷面平整度的依據。接下來，以噴漿機作業，噴塗方法可由下而上或由上向下呈 S 型路線噴塗，打底作業完畢待其呈半硬固狀態時，再以灰誌爲基準點刮去牆面上多餘的沙漿，若是不足再予以補充厚度，反覆作業直到要求的厚度爲止。噴漿作業如圖 2 所示。

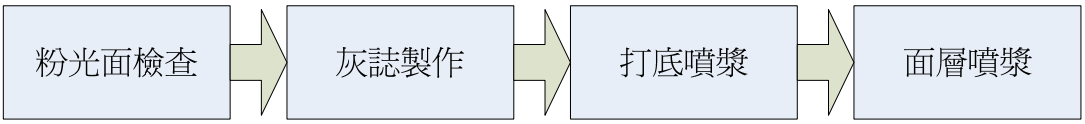

圖 2 噴漿作業流程圖

二、因素探索

利用執行六標準差管理之邏輯路徑，來達到專案改善的目的，詳細操作步驟說明如下：

(一)流程展開

流程展開之目的係因在營造噴漿作業的流程中所發生的缺失及不良是來自於營造流程中些許因素產生變異或者是未被有效控制所發生的，因此透過流程圖展開來尋找營造流程中的營造程序步驟、輸入變數、輸出變數，並了解輸入因素及輸出因素之因果關係，而此專案的輸出因素即爲本專案的問題所在，分別爲表面平整度以及牆面龜裂。當流程圖完成之後，即接著因果矩陣圖來篩選關鍵輸入因素。

在流程圖展開的操作時會針對每個輸入因素作特性的分類，以 C、U、X、S 分爲四類，以利後續分析。以下則是 C、U、X、S 分別之涵義：

1.C：可控制輸入因素，表示該因素的作業程序是可以改變的，當然也是後續改善項目的選擇。

2.U：不可控制輸入因素，表示該因素的作業程序是無法有效控制的。

3.X：重要因素，表示該因素是影響整體流程的重要項目。

4.S：作業標準程序，表該因素現已有作業標準程序作流程的管控動作或依據。

經過本工具的分析結果，噴漿作業流程是由 4 個工作程序步驟所組成，共 60 項輸入因素，其中包含可控制輸入因素共 35 項、不可控制輸入因素 25 項、重要因素 10 項、已有作業標準程序者 29 項，然而在這之中，要注意可控制輸入因素沒有作業標準程序者，若在後續分析中判定爲關鍵因素，則應設立該輸入因素之作業標準程序，如此才能掌握因素變異，而不可控制輸入因素則因設法掌握品質，確保在使用時有不良情況發生。流程圖展開後，將進行下一步驟因果矩陣圖來進行篩選。流程圖展開如表 1 所示。

表 1 部份流程展開圖

輸入變數	類別				流程	輸出(品質特性)
	C	U	X	S		
					灰誌製作	平整度 龜裂
人員的技術		√			拉水平線 灰誌製作(麻藷) 樑及柱 V 型基準灰灰誌(棒角) 牆灰誌	
人員的細心度		√		√		
水線的鬆緊度	√		√	√		
水泥漿的粘著性	√		√	√		
水泥漿的深淺度	√					
水線的間距	√			√		

(二)利用因果矩陣圖（Cause and Effect Matrix）篩選關鍵步驟以及影響因素

利用流程圖展開後，找出了許多與輸出變數相關的輸入變數。接著再利用因果矩陣圖來篩選出影響噴漿作業品質關鍵輸入因素。專案小組先將輸入變數放在表的左方，而將關鍵輸出變數(KPOV)放在表的上方，然後依照顧客的關注的程度大小以 1-10 的給予關鍵輸出變數權數。接著，再討論輸入變數與關鍵輸出變數的關聯程度的大小以 0,1,3,9 給予評分，而在此 9 分爲強相關、3 分爲中度相關、1 分爲弱相關而 0 分爲無相關。經過因果矩陣圖篩選分析後，專案小組篩選出 4 個關鍵輸入因素，分別是：水泥攪拌的均勻度、噴頭的清洗頻率、水泥與砂的配合比例、噴頭的仰角。因果矩陣圖如表 2 所示。

表 2 部份因果矩陣圖

		龜裂	平整度	沙漿稠度	
流程步驟	輸入變數	10	10	7	總分
打底噴漿	水泥攪拌的均勻度	9	9	9	243
面層噴漿	水泥攪拌的均勻度	9	9	9	243
打底噴漿	噴頭的清洗頻率	9	3	9	183
面層噴漿	噴頭的清洗頻率	9	3	9	183
打底噴漿	水泥與砂的配合比例	9	3	9	183
面層噴漿	水泥與砂的配合比例	9	3	9	183
打底噴漿	噴頭的仰角	9	3	9	183
面層噴漿	噴頭的仰角	9	3	9	183

三、因素驗證

利用前述工具的分析結果有四個因素是有可能影響到單位缺陷率，分別是：水泥攪拌的均勻度、噴頭的清洗頻率、水泥與砂的配合比例、噴頭的仰角。因此，我們藉由資料的收集來驗證其中一個因素－噴頭的清洗頻率。另外三個因素，因爲都有業界的規範，因此可以直接利用失效模式分析找出失效原因而擬定管制計畫來控制。而在驗證這些因素之前，小組懷疑是否有其他的噪音變數會影響到製程。因此，針對高度懷疑的噪音變數來進行驗證，選擇的是不同作業員。製程因素的分析以及驗證如下：

(一)噪音變數分析：不同作業員是否會影響單位缺陷率：

本研究將先針對不同的作業員是否會影響噴漿之後的品質項目綜合評比進行研究分析，也就是將施工之後的牆面隨機取樣，以每 30 平方公分爲基準找出缺陷項目計算每平方米之單位缺陷率，利用統計軟體 MINITAB 進行資料分析，根據假設檢定並使用變異數分析(ANOV)分析找出 p 值判定此因素是否對噴漿之後的平整度具有顯著影響。而統計假設如下所示：

假設檢定 1：

Ho：不同作業員對於噴漿之後的品質並沒有差異

Ha：不同作業員對於噴漿之後的品質具有顯著差異

經過 MINITAB 運算之後所顯示的 p 值爲 0.268，p 值大於 0.05，因此接受 Ho，分析結果如表 3 所示。表示不同作業員對於噴漿之後的平整度並沒有差異，代表此因素爲非顯著。

表 3 變異數分析表

One-way ANOVA:					
Source	DF	SS	MS	F	p
Op	2	0.01501	0.00751	2.19	0.268
Error	3	0.01027	0.00342		
Total	5	0.0252			

(二)關鍵變數分析與驗證：

接下來針對幾個關鍵變數進行統計的驗證與分析，分別利用以下假設檢定來進行噴頭的清洗頻率的顯著性驗證。而此因素，我們找出 3 個水準，分別是使用後 2 小時、6 小時與 8 小時後清洗。根據假設並使用變異數分析(ANOVA)找出 p 值判定此因素是否對噴漿之後的品質項目綜合評比具有顯著影響。資料也依照上段所述進行取樣，而統計假設如下所示：

假設檢定 2：

Ho：不同頻率對於噴漿之後的品質並沒有差異

Ha：不同頻率對於噴漿之後的品質具有顯著差異

經過 MINITAB 運算之後所顯示的 p 值爲 0.023，p 值小於 0.05，因此拒絕 Ho，分析結果如表 4 所示。不同頻率對於噴漿之後的平整度具有顯著差異。再利用 Fisher's LSD 檢定法進行多重比較，結果發現每個水準皆存在顯著差異，分析結果如表 5 所示。而以頻率 2 小時清洗的數據爲最佳，因此可推斷若是以 2 小時清洗則具有最好的效果。因此建議將來在管理上設定爲每 2 小時清洗噴頭。

表 4 變異數分析表

One-way ANOVA:					
Source	DF	SS	MS	F	p
Frequency	2	0.015114	0.007557	33.39	0.023
Error	3	0.000679	0.000226		
Total	5	0.015793			

表 5 Fisher' s LSD 檢定法分析結果

Fisher 95% Individual Confidence Intervals All Pairwise Comparisons among Levels of Frequency			
Frequency = 2 subtracted from:			
Frequency	Lower	Center	Upper
6	0.04436	0.08850	0.13264
8	0.08986	0.13400	0.17814
Frequency = 6 subtracted from:			
Frequency	Lower	Center	Upper
8	0.00136	0.04550	0.08964

三、失效模式分析找出影響關鍵因素真因

透過因果矩陣圖篩選出關鍵輸入因素及統計方法確認關鍵輸入因素之後，再進行失效模式分析找出潛在影響關鍵輸出因素的關鍵輸入因素真因。失效模式分析是一個確認流程關鍵變數可能發生失敗的各種方式，並消除或降低其發生的機會的方法。利用失效模式分析可以將關鍵變數每一個可能發生之潛在失效模式找出來，然後探討可能發生的原因爲何即可針對發生原因來建立消除變異的措施以及管制方法，如此就可以達到預防的目的。失效模式分析的工具具有詳細的操作格式，不管是針對零件或是流程的關鍵數入變數都是從潛在失效模式的分析開始，探究造成的效應、原因及管制機制，然後賦予關鍵等級或嚴重等級計算風險值(Risk priority number, RPN)，最後提出改善意見(Puente et al., 2002)。而風險值即是利用前面分析的失效發生產生的效應、引發原因的發生頻率及失效被查偵的可能性之乘積來計算。計算式如下：

RPN(風險值) = SEV × OCC × DET

其中，SEV：失效造成的效應嚴重程度；OCC：引發失效原因的發生頻率；DET：失效被查偵的機率。每項的分數都是給予 1-10 的範圍，因此 RPN 的範圍從 1-1000，該數值愈大則表明這一潛在問題越嚴重，越應該及時採取糾正措施，以便努力減少該值。表 6 爲失效模式分析部份的結果。

表 6 失效模式分析

關鍵輸入變數	失效模式	效應	SEV	引發原因	OCC	目前管制機制	DET	RPN	改善方向
水泥攪拌的均勻度	水泥不均勻	牆面龜裂	10	沒有適當的抽檢制度	7	無	10	700	建立以美軍標準 1916 的抽樣機制進行抽驗以確保均勻度符合規格
噴頭的清洗頻率	水泥無法噴出	粉刷面不平整	10	不知道最佳清洗頻率	7	無	10	700	經過實驗證實，每工作 2 小時之後清洗可以讓水泥的噴出更順暢
水泥與砂的配合比例	沒有依照比例調配	施工面不平整	10	沒有適當的抽檢制度	7	無	10	700	建立以美軍標準 1916 的抽樣機制進行抽驗以確保均勻度符合規格
噴頭的仰角	角度太高或太低	牆面不平整、重合處容易龜裂	10	員工不清楚操作規範	6	無	10	600	建立現場抽查的制度，隨時抽查員工操作情形

四、關鍵變數控制

管制計劃表在整個分析過程的最後。爲了有效的掌控各關鍵輸入因素發生變異而建立各種防範計畫，也會針對各關鍵輸入因素建立可行改善方式並建立管控標準計畫。管制計劃表如表 4。

表 7 管制計劃表

關鍵輸入變數	操作規格	管制方法	取樣大小	取樣頻率
水泥攪拌的均勻度	依照作業規範	查檢表	依照 MIL-STD-1916 抽樣	每次作業前
噴頭的清洗頻率	每 2 小時清洗	查檢表	全檢	每次作業完畢
水泥與砂的配合比例	依照作業規範	查檢表	依照 MIL-STD-1916 抽樣	每次作業前
噴頭的仰角	依照作業規範	查檢表	全檢	每次作業中抽檢

經過了改變的施工方法及利用管制計畫持續的管制施工流程，專案小組發現牆面的嚴重品質問題發生率從改善前的 27%降低至 3.5%，效果卓著，顧客滿意度也隨著提升。

肆、研究發現以及總結

本研究是以個案研究的方式展現六標準差管理解決噴漿工程的品質問題。其中我們發現利用流程分析的工具找出影響品質的關鍵點，如：水泥攪拌的均勻度、噴頭的清洗頻率、水泥與砂的配合比例、噴頭的仰角等，同時也利用統計方法進行因素的驗證，如：利用變異數分析確認噴頭的清洗頻率爲關鍵變數，而再利用Fisher’s LSD檢定法找到最佳清洗頻率爲2小時。最後配合管制計畫控制關鍵輸入變數，使得噴漿工程發生牆面不平整及龜裂的比例大幅降低，顧客滿意度也隨著提升。而個案公司在執行此專案也獲得其他的效益，如：訓練工程師以不同的思維解決問題。六標準差模式是一種系統性的方法，透過邏輯的分析找出會影響流程的關鍵因素，並且可以利用失效模式分析，統計方法有效的找出各影響關鍵因素的真因，對於營建工程師而言這是全新的解決問題的思維，也幫助個案公司建立了持續改善的觀念。因進行六標準差管理並不僅僅是要掌握關鍵因素，還要有計畫的將這些關鍵因素利用嚴格的管制計畫進行關鍵因素的控制，接著擬定長期的對策，不斷的改進再改進，如此的改善才能使營造廠商能有競爭性的效益。

在台灣的營建業中，執行品質改善較少使用如同六標準差管理具有清楚邏輯路徑的方法來解決問題，因此常常讓人員不知如何進行改善或是改善後治標不治本而沒有辦法真正的解決問題。雖然六標準差管理在其他領域已經被廣泛的使用，而六標準差管理在

營建業來說相對是比較新的品質管理手法，因此藉由此案例所展現的使用六標準差工具的過程，可以帶給許多營建公司新的想法及品質改善的做法，本研究的研究結果將可以給營建業做爲參考。

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網路負面口碑之探索性分析

An Exploratory Study of Online Negative Word-of-Mouth Communication

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摘　要

本研究討論負面口碑之效果，以台灣地區最大之 3C 行動通訊論壇 mobile01 為研究標的，並選取筆記型電腦作為本研究之範例。實證樣本共收集 7930 則討論區文章，採內容分析方法研究。結果發現筆記型電腦討論區的文章內容仍以技術交流佔最大宗，其次為消費者尋求網友的購買建議，而網路負面口碑僅佔全部樣本的 6.97%。然而，針對不同類型文章與回覆次數及討論期間做交叉比對，明顯看出網路負面口碑所引發的討論最為熱烈，平均每篇負面口碑會引發另外 54 則回應訊息，而正面口碑平均只引發 25 則的回應。此外，負面口碑更會引起許多網友分享類似的負面經驗，進一步造成品牌形象更大的傷害。研究亦發現負面口碑的討論期間較長，平均每則負面口碑會讓消費者持續關注達 80 天，顯見負面口碑訊息的傷害相當大。有鑑於此，企業必須發展務實的網路負面口碑管理方式；其中，本研究發現企業派遣正式員工駐站服務之效益非常高，本文亦於結論中一併討論。

關鍵詞：口碑、推薦、閒聊、消費者行為、社群媒體

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Abstract

This study discussed the effects of negative word-of-mouth communication by investigating the laptop computer issue related to Taiwan's largest mobile communication forum, Mobile01. In total, 7,930 posts were collected and examined via content analysis. Results indicate that types of "technical information exchanges" and "opinion seeking" dominated in discussion trends. Specifically, discussions regarding negative word of mouth on the Internet accounted for only 6.97% of all interactions. However, a cross-validation of different posts, responses, and discussion periods indicated that negative word of mouth triggered the most heated discussions, averaging 54 responses per post, whereas positive word of mouth generated only 25 responses per post. In addition, negative word-of-mouth discussions attracted users with similar negative experiences, which further damaged the brand's reputation. The discussion duration on negative word of mouth was also substantial and, on average, continued for as long as 80 days. Evidence from this study revealed that negative word of mouth can cause significant damage. For these reasons, companies must develop practical systems to manage negative word of mouth on the Internet. Implications for customer management are discussed.

***Keywords**:* word-of-mouth, referral, buzz, consumer behavior, social media

I. Introduction

The Internet has dramatically changed the way word of mouth (WOM) is transmitted. In the past, WOM communication disappeared immediately after it was shared. However, today, online WOM permanently circulates on the Internet in the form of text, audio, and many other multimedia. This rich multimedia-form of WOM provides plenty of information for potential consumers to review before making purchase decisions. Moreover, enhanced search engines enable users to produce precise search results instantaneously. Consequently, consumers are now used to searching for product reviews on the Internet before finalizing their purchase decisions (Chatterjee, 2001), which further assists the spread of electronic WOM.

To cope with this trend, companies are currently actively promoting positive WOM (PWOM) on the Internet as intangible assets (Chen, Wang, & Xie, 2011). Similarly, negative WOM (NWOM) is treated as intangible liabilities that also deserve attention (Berger, Sorensen, & Rasmussen, 2010). In fact, many companies have begun showing concern related to this issue. For example, Dell monitors WOM on the Internet in order to respond to consumers' negative comments before they spread. Some enterprises have also taken initiatives to prevent possible malicious attacks by pre-registering domain names. For instance, Volvo has registered volvosucks.com while Chase Manhattan Corporation now controls chasesuck.com, ihatechase.com, chasestinks.com, and chaseblows.com (Harrison-Walker, 2001).

Marketing practitioners monitor NWOM because its impact is believed to be greater than that of PWOM (Gilly, Graham, Wolfinbarger, & Yale, 1998). Hennig-Thurau and Walsh (2003) indicated that 43.5% of consumers who read negative comments online are discouraged from purchasing certain products, while only 28% of consumers consider buying products after reading positive reviews. In addition, due to the highly accessible nature of the Internet, consumers are typically more likely to express their dissatisfaction online rather than directly file complaints to the company. In fact, nowadays consumers are used to taking to the Internet as the best channel to share their dissatisfaction (Harrison-Walker, 2001).

While the impact of online reviews continues to grow, systematic management remains inadequate. Previous studies have focused on investigating the roles and characteristics of online review sources (e.g., Chandrashekaran, Grewal, & Mehta, 2010; Wangenheim, 2005; Ward & Ostrom, 2006) and the motivation behind spreading or searching for WOM on the Internet (e.g., Hennig-Thurau, Gwinner, Walsh, & Gremler, 2004; Hennig-Thurau & Walsh, 2003). The current study seeks to provide a preliminary examination of online WOM. By examining the contents of online WOM, the authors are able to identify different types of WOM information. The results of this study will facilitate our understanding related to the influence of NWOM and serve as a reference for practical management.

II. Literature Review

A. WOM on the Internet

WOM is a method of communication that is independent of manufacturers, retailers, and service providers (Arndt, 1967). WOM participants usually include family and friends; therefore, it is believed to be more trustworthy than any other media sources (Derbaix & Vanhamme, 2003). In addition, the interactive nature makes it possible for the WOM sender to give a customized suggestion that is better suited to the WOM receiver's needs (Bristor, 1990). Researchers assert that WOM is usually more vivid and memorable, provokes empathy, and is more persuasive than other sources (e.g., Herr, Kardes, & Kim, 1991; Silverman, 2001). Hughes (2005) pointed out that WOM is valuable because it immediately captures the attention of consumers, which is a scarce resource in the digital world. Therefore, the importance of WOM in influencing consumer attitudes and purchase decisions has been widely recognized by marketing scholars (e.g., Bansal & Voyer, 2000; Wangenheim & Bayón, 2004).

Online WOM refers to consumer accounts of experiences and opinions on products that are transmitted online (Dellaroces, 2003). Consumers distribute WOM messages via diverse online media, including E-mails, newsgroups, online forums, blogs, and Twitter (Hennig-Thurau et al., 2010). Thanks to the continual improvement of the Internet's construction, WOM messages today are transmitted even faster, thereby providing researchers with opportunities to conduct related studies. For example, Kiecker and Cowles (2001) discussed the roles and characteristics of online review sources and classified WOM sources into different categories. Liu (2006) found that online WOM reviews of movies were mostly positive during the prelease stage; however, negative reviews drastically increased during opening week. Nevertheless, he found that WOM volume significantly influenced box office revenue, whereas the effect of WOM valence was not salient. Chevalier and Mayzlin (2006) studied online book reviews and found that consumers had a positive bias to posted positive book reviews. Studies have also shown that consumers not only review online book ratings, but also read reviewers' comments critically (Chevalier, 2006). These results indicate that negative comments influence consumers more than positive ones. Other studies have examined online forums (Cheung, Luo, Sia, & Chen, 2009), blogs (Kozinets, de Valck, Wojnicki, & Wilner, 2010), social networks (Dwyer, 2007), and opinion platforms (Hennig-Thurau et al., 2004); findings indicate that online WOM is a highly useful venue enabling businesses to monitor customers' responses to their products (e.g., Godes & Mayzlin, 2004; Hu, Pavlou, & Zhang, 2006).

B. Negative word of mouth

When consumers are dissatisfied with a purchased product, they may take public actions (e.g., filing claims or making legal complaints) or adopt non-public actions to release their anger (e.g., not buy the product anymore or warn their friends not to buy it). NWOM is a non-public action in which consumers decide to relate their unpleasant experiences to friends

and family (Ward & Ostrom, 2006). NWOM has historically been difficult to observe; consequently, previous research focused on consumers' complaint behavior. It was not until the 1980s that scholars began investigating NWOM, although their focus was still on the antecedent variables that led to these negative reviews (Halstead, 2002; Nyer & Gopinath, 2005).

Transmitting WOM messages on the Internet is vastly different from speaking these messages aloud. Online reviews are exchanged indirectly via non-verbal messages, are directed to multiple individuals, and are available to any other consumers for an indefinite period as interconnected files communicate this information, which can be subject to observation (Keller, 2007). Although many studies have investigated the management of NWOM on the Internet, this process has not been systematically developed; however, a relatively vast collection of research on consumer complaints in the literature can be referenced. Best and Andreasen (1977) found that nearly 20% of after-sales complaints concerned pricing. Anderson (1994) and Fornell (1992) indicated that consumers are more likely to feel satisfied with the product than they are toward the service. Harrison-Walker (2001) pointed out that, unless consumers file complaints immediately following the problem, companies are not be able to remedy the situation. For this reason, enterprises should encourage customers to voice their complaints directly when problems arise.

However, empirical research has also found that only a small number of consumers direct their complaints to the company; 70% of consumers either stop buying these products entirely or criticize them among friends and family (Day et al., 1981). Furthermore, some consumers believe that filing complaints is a waste of time because they are unlikely to receive satisfactory results, whereas others are simply not familiar with complaint filing procedures and channels (Bodey & Grace, 2006). Moreover, many consumers continue to voice dissatisfaction to friends and family even after they file a complaint to the company. Considering these lines of potential NWOM, criticisms made in public could deter potential consumers and cause persistent negative attitudes toward products.

Although NWOM on the Internet has far-reaching consequences, Strauss and Hill (2001) found that only 47% of companies responded to consumer complaint e-mails. However, with the convenience of the Internet, many consumers take online forums as their first and the most important place to voice their dissatisfaction (Harrison-Walker, 2001). Therefore, online discussion forums have become the main channel for the spreading of NWOM.

C. Motivations for the spreading and reading of online word of mouth

Since the importance of online WOM continues to grow, many scholars have investigated the motivation behind consumers' publication and reading of online reviews (e.g., Goldsmith & Horowitz, 2006; Hennig-Thurau & Walsh, 2003). The main reason for posting online reviews is the belief that other consumers may benefit from this information, followed by coincidental communication during the process of a discussion. The third reason for this type of communication is to release emotions and highlight either positive or negative experiences with certain products. Of note, only 3.4% of online discussion is triggered by

marketing campaigns (Hennig-Thurau et al., 2004). Chevalier and MayzLin (2006) found that online book reviews are generally positive, while Schlosser (2005) indicated that consumers have a negative bias because they try to provide different opinions by publishing negative or opposing reviews.

The main reasons consumers review WOM on the Internet are to reduce perceived risks and accelerate the decision-making process (Hennig-Thurau & Walsh, 2003). Moreover, these reviews provide first-hand insights into product experiences and determine social status conveyed by the products. Goldsmith and Horowitz (2006) further indicated that price consciousness is another major factor for people to read online WOM.

III. Method

The purpose of this study is to conduct a preliminary analysis of the content of online WOM and identify its effects in view of how heated each post is. Although individuals can communicate in many ways via the Internet, this study only examine messages that are publicly accessible, such as those posted on bulletin board systems (BBS) or in forums. Private opinions exchanges (e.g., through e-mails, instant messaging tools, or private chat rooms) are not observable by the public and therefore are not suitable for analysis. Considering the characteristics of different forms of websites, we selected an online forum as our data source because this type of website is focused primarily on the exchange of consumer opinions or experiences. Therefore, it is the best venue for the distribution of online WOM.

This study selected the laptop discussion forum as our data source for two important reasons: (1) Laptop computers have continually been a key product in Taiwan's economy, with 80% of the world's laptop computers being produced or assembled by Taiwanese original equipment manufacturers (OEMs), resulting in numerous competing brands in Taiwan; this situation facilitated a comprehensive collection of related information. (2) Laptop computers have replaced their desktop counterparts as mainstream products, generating a considerable number of consumers and an equally substantial amount of related discussion. Mobile01, the largest mobile communication forum in Taiwan, was chosen as our data source. Mobile01was established in February 2003; since then, it has become Taiwan's largest mobile communications forum. According to Internet traffic reports on Alexa at the time of this study, Mobile01 ranked fourteenth in total Internet traffic (including such as Google, Yahoo!, Facebook, Wrech) but number one when considering only the laptop forum category.

This study employed content analysis to classify and analyze online reviews. Because posts in Mobile01 were previously sorted according to the heat of the discussion and the date of the latest replies of that post, it was not possible to use the date of first post as the basis for sampling. Therefore, the sample was drawn according to the "last reply date." A four-month timeframe (June to September 2009) was selected to provide adequate time for subsequent analysis. Although consumers usually purchase new laptops every two to three years, and

each new laptop generally attracts consumers' attention for only about three months (Huang, 2005). Moreover, since we drew our sample according to the last reply date, the time span between the dates of the "first post" to the "last reply" could be very long. In fact, the longest duration of the discussion in our data is beyond five years. Thus, the four-month time frame is adequate for an exploratory analysis.

After the data were collected, we used content analysis to quantify and analyze the words, concepts, and relationships within each post. This method is advantageous for understanding social communication and interaction. The procedure to develop the coding scheme of the study referred to past research for guidance. In the first stage, two of the authors examined a small sample of posts and created categories independently (Godes & Mayzlin, 2004). The coding schemes were then compared with each other as well as with past research. Finally, seven categories were identified. In the second stage, two judges were recruited and trained to re-examine all of the posts and were asked to sort the posts into the categories separately. Disagreements in codings were resolved by discussing key terms and jointly reviewing the posts until a consensus was reached. Ultimately, 7,930 posts were collected. Among them, five posts including log files of incorrect posts and lack of content were omitted from subsequent analysis.

IV. Results and Discussion

A. Duration of different kinds of word of mouth on the Internet

The data collected from Mobile01 suggest that consumers did not publish many negative comments on the Internet. Table 1 shows "technical exchanges" that focused on laptop computer hardware and software accounted for nearly half of the discussion, followed by "purchase opinion seeking" and PWOM, whereas NWOM accounted for only 6.67%. Excluding the discussion of consumers' sharing of "Great Deals" and "company-supported activity" initiated by businesses, negative reviews generated the fewest posts among consumer-initiated topics. However, when observed according to time span, the average discussion time span on NWOM continued for as long as 80 days. The period of time was counted according to the time span between the first dates of the post to the last reply to that topic. According to Preece et al. (2004), more people viewed than posted, suggesting that NWOM on the Internet is reviewed longer than indicated by the period observed in this study.

Table 1 Duration of Discussion Topics

Discussion Topics	Percentage	Number of case	Average Discussion Time (Days)	Standard Deviation
PWOM	12.44	986	78.59	137.36
NWOM	6.97	552	79.94	163.74
Purchase Opinions Seeking	18.41	1459	19.87	73.94
Technical Exchanges	48.26	3825	27.98	78.06
Great Deals	3.97	315	23.88	21.75
Social Interaction	9.64	764	39.87	168.23
Company-supported Activity	0.31	24	67.71	161.33
Total	100	7925	42.17	129.47

Note: Five unrelated discussions were removed from final analysis

As the standard deviation of many categories is very high, it is worth further examining posts by time span. The longest discussion of posts, lasting for 1,977 days, related to "social interaction." This post called for all members on the forum to sign in and share the laptop brand they were using at the time. "Technical exchanges" was also a hot topic; one pose in this category focused on wireless connection and lasted for 1,955 days. In fact, topics about how to fix, adjust, monitor, or set up hardware and software were very popular in this forum. For example, topics such as "how to monitor your notebook's temperature" (1,906 days), "9 steps to set up your XP-embedded system" (1,803 days), and "[Report] I tear down my Acer travelmate" (1,566 days) generated a lot of conversation.

Popular PWOM posts generally related to someone sharing his/her hot new fashion gear or a smart purchase decision. The hot posts tended to contain a lot of personal feelings and were supported with many product photos. Consequently, they engaged many posters to respond or consult when they were also interested in that product. For example, the topic "[Buy it] the best of blue-tooth mouse ~VAIO VGP-BMS30" continued garnering notice for 1,456 days; "The wing of phoenix! ThinkPad X41 tablet" attracted members' attention for 1,414 days.

Posts with all kinds of NWOM in general were also eye-catching issues. Topics such as bad salespersons, dishonest retailers, bad product experiences, major product defects, and insufficient product support attracted a lot of discussion. For example, the discussion related to the post "My disastrous experience of buying laptop in GUANG-HUA market" lasted for 1,351 days and "Don't buy Acer if you are going abroad" aroused debate for 1,146 days.

A very special case comes from company-supported activity, which primarily includes some sort of official introduction before a new laptop model is launched. These posts usually do not last for long. However, the average discussion time in this category was up to 67.71 days. After reviewing the data, an outlier was found. The post "Joybook service place—Banq superman" by a Banq's serviceperson was welcomed by forum members; in this post, he

officially asked Joybook laptop users to submit their questions to him on the forum, resulting in numerous replies.

B. Topics people preferred to chat about

In addition to examining the duration of discussions, we also considered the popularity of each thread based on the number of responses to the messages. These numbers reflect the participation levels of the topic. Table 2 shows that NWOM on the Internet generated the most discussion among users, with posts generating an average of 54 replies. The participation level of this topic was far greater than that of other topics and even surpassed "Great Deals (39.5%)," a topic that has the potential to substantially benefit users.

Table 2 Discussion Topic Reply Status

Subject	Average Number of Responses	Standard Deviation
PWOM	25.16	23.32
NWOM	54.00	104.91
Purchase Opinions Seeking	11.51	15.14
Technical Exchanges	11.73	33.41
Great Deals	39.50	47.80
Social Interaction	13.56	28.17
Company-supported Activity	52.21	156.79
Total	18.46	41.12

The hottest topic was the one posted by the Banq serviceperson, which generated 792 replies. The second is a technical article that compared the efficiency of the major laptop brand in 2009. The third and the fourth came from "Great Deals" and shared links to special offers by Dell and a call for group buying. Consumers complaining about the lack of drivers and recovery disks for Acer laptops also attracted a lot of attention, resulting in 412 replies to this topic. NWOM (e.g., a call to "sign in for bad battery of SONY laptop" and "sign in for defected eeepc 900 16g") were strongly supported by people with the same problems.

C. Who join to NWOM discussion

Since online NWOM provides a lot of opportunities for the public to evaluate these messages, companies should pay attention to the dynamic effects of each NWOM episode. After reviewing all of the NWOM incidents, except for those responses that could not be categorized (e.g., private messages, exchanges of contact information, or unrelated posts), this study classified the roles of participants who joined NWOM discussions into five categories. The following discussion used the post "deeply disappointed about Acer. They don't give you driver and recovery disks" as an example. The original poster tried to contact Acer for a driver disk and was asked to pay 800 NT dollars to restore the system service. His post aroused a lot of debate, resulting in five types of responses:

(1) Followers:
This type of user supported the original poster by sharing their related negative experiences or publicly expressing their opinions to jointly blame the company for its unfair action. The appearance of followers demonstrates the power of accumulative NWOM on the Internet and encouraged users to protest against unfair treatment. For example, one consumer replied "Acer sucks, the drivers on the official website lose connection most of the time."
(2) Defender:
This type of user expresses opinions that are contrary to that of the original poster. Some believed that the problem is due to users' misunderstanding or that problems with a service encounter are the consequence of the consumer's faults. Discussions are usually heated when varying opinions arise. For example, in Acer's case, consumers replied "hi man! it is very normal, ok! Almost no companies provide driver disks nowadays, you can burn it yourself from your hard disk."
(3) Impartial third party:
This type of user remains impartial throughout the discussion and is not biased toward either the original poster or the vendor. Although this type of user does not explicitly express their support for a business, their opinions often reduce the harmful effects of NWOM and thus minimize potential damage. For example, one poster wrote "for environmentally friendly reasons, it is true and reasonable that most companies do not provide driver disks; but, I think they could provide an easier way to access laptop drivers. Some consumers are not so familiar with computer setup, after all."
(4) Problem solvers:
These users provide specific guidelines to direct the posters to either formal or informal channels to solve their problems. This assistance may be the product of maintenance resources (such as sharing tips or other online resources), official channels, or related knowledge to compensate for the inadequacies in the official assistance provided by the business. For example, one replied to the post by telling the original poster how to burn the driver disk from his own hard disk. Another one poster wrote "hi, don't get angry, here is the link of your drivers; click to download IOS files."
(5) Business representatives:
In this study, only once did a company representative provide an official response to a complaint on the forum. However, vendors could also have registered as common users to post positive feedback about their company. Nevertheless, when newly registered users support a business, other users might suspect that the company itself is pretending to be general users, which could generate adverse effects. There is no official response in this case. The company does not seem to care about what consumers are talking about on the Internet. The only case included in the NWOM discussion was a call for an official explanation about a pricing issue.

V. Conclusion and Implications

Using content analysis to explore the content of online WOM in the Mobile01 forum, we identified seven major WOM categories. We found that "Technical Exchanges" and "Purchase Opinions Seeking" dominated the whole forum. These two topics account for almost 70% of the discussion. Moreover, as findings from the current study indicate, consumers are more willing to share positive comments than lodge negative complaints on the forums. This finding is consistent with that of Chevalier and Mayzlin (2006), which suggests that "reviewers will have a positive bias in their evaluation compared with general population." As suggested by Chung (2001), the self-promotion motive will induce consumers to give more positive WOM than negative WOM.

This exploratory study investigated the role of NWOM on the Internet. A content analysis of the laptop discussion forum on Mobile01 demonstrated that people exchange opinions on the Internet, but no business representatives or spokespersons manage these exchanges. The results of this study also confirmed that, although negative online reviews account for just a small percentage of the total discussion, they received far more responses than other discussion topics. Therefore, neglecting the impact of such discussions could damage a company's intangible brand assets.

Companies that seek to minimize negative online reviews should train their service personnel. The NWOM identified in this study focused primarily on unsatisfactory service encounters, which caused intense feelings of resentment. In fact, a vast majority of NWOM messages on the Internet imply unsatisfactory services. A typical example is consumers who seek repairs on defective products and find significant discrepancies between service guidelines and product liability problems. In these cases, dissatisfied consumers tend to spread NWOM messages on the Internet. Furthermore, when consumers encountered laptop-related problems, most sought remedial measures by first contacting the manufacturer directly. Therefore, if businesses can provide appropriate services when consumers actively approach them, customers might hold a more positive view of the enterprise, even if the problems remain unresolved. One of the posts related the experience of a consumer who sought manufacturer assistance to improve defects in a product; yet, the problem remained unresolved. However, due to enthusiastic staff reception and reasonable service procedures flow, the consumer still gave the company positive feedback.

The most important implication from the current study is the need to offer online service on the forums. We examined the hottest and the longest duration of the posts, discovering that a Benq's employee provided online service in a very successful platform. It doesn't mean that consumers do not complaint about banq's laptop; however, each time consumers encountered a problem, they actively contacted banq's serviceperson by replied his post. The ease of access to the serviceperson is very important in preventing the spread of NWOM. An online service post will change a consumer's behavior from initiating a negative comment to

replying the service post. Since most people will not examine other users' reply information, a service post may largely cut down the spreading of NWOM.

VI. Limitations and Directions for Future Research

This research is subject to several limitations. First, although we collected 7,930 pieces of data from the major Mobile forum in Taiwan, our sample may not have been representative of different industries. Thus, our findings are exploratory in nature and need to be examined in different contexts. Second, the relative impact of positive versus negative WOM is only determined by comparing the duration and responses of each post. Tables 1 and 2 indicated that the standard deviations of each category are potentially high. According to these results, simply distinguishing positive and negative WOM is not enough to depict the entire picture of the effect of online WOM. There must be some factors that make PWOM more powerful and some factors that make NWOM more harmful. Although we provide some preliminary observations, these possibilities need to be more fully explored in future research.

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以 LASSO 選模探討影響學生滿意度的重要服務品質構面

Identify the Key Dimensions of Service Quality for Student Satisfaction by LASSO Method

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摘　要

本研究採用 SERVPERF 服務品質評量方式衡量清雲科技大學的服務品質，主要的內容分成三個部份。第一，分析學生對學校服務品質的評價與學校政策努力的相符情形。第二，利用探索式因素分析，將服務品質變數分成教師專業、學校關懷、空間硬體、課後活動、行政支援與就業輔導等六個構面。第三，以 LRM 描述學生滿意度與服務品質的關係，利用 LASSO 模型篩選法，判定影響學生滿意度的重要性依序為教師專業、就業輔導與行政支援，另外，證實學生對學校服務品質評價的高低與滿意度的重要性無關。根據上述分析，本研究最後對改善服務品質以提升學生滿意度指出重點方向與建議。

關鍵詞：服務品質，因素分析，模型篩選

Abstract

In this study, the questionnaire based on SERVPERF scale for measuring students' perceptions of the service quality at Ching Yun University has been developed. Six dimensions of service quality are identified by exploratory factor analysis. The relationship of student satisfaction and service quality is described by a logistic regression model. The LASSO model selection is used to identify the key dimensions for enhancing student satisfaction. Several suggestions for continuous quality improvement at our school are provided at the end of the paper.

Keywords: service quality, factor analysis, model selection

壹、緒論

台灣教育界現在面臨的共同問題是出生率低造成學生來源減少，而教育部過去開放新設大學使招生員額過多的供需失調的問題。相對而言，這個問題對私立科技大學或技術學院的衝擊最大。反應在過去 10 年招生錄取率與學生報到率等統計數據的變化，讓各個學校在經營上無不膽戰心驚，其競爭日趨激烈尤甚很多企業之經營。圖 1 爲 1987 年至 2009 年間的新生嬰兒總數趨勢圖，1997 年前此曲線略呈水平，而後人數急遽下降到不及高峰時期的一半。1990 年代，政府開放設立新校與鼓勵技職教育升格轉型，使得原有 100 餘所大專院校增爲現今 164 所，學生總數更由約 40 萬人增爲 134 萬人。這僅是統計實際就讀學生人數，而教育部核定招生人數則超過此數。表 1 爲 2009 年四技二專招生與錄取人數，總計招生人數約 18 萬餘人，但僅錄取約 14 萬人，不足額人數達到 4 萬人之多。此趨勢隨少子化的效應，將使高教面臨更爲險峻的經營環境，愈來愈不利私校的經營。

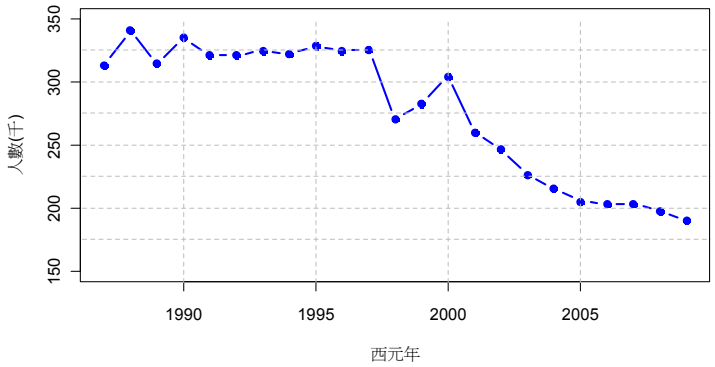

圖 1　1987-2009 年新生嬰兒總數趨勢圖

大學數量與招生人數急遽擴增，使得社會對於大學教育的品質充滿疑慮。教育部爲了有效控管各大學，特別是私立科技大學的教學品質，極力推動大學評鑑制度的建立，並據以實施評鑑評比。評鑑等第攸關教育部對招生員額的核定，給予差異性的獎補助款，這等第或評鑑結果將對學校招生的宣傳產生廣告正面或負面的效應。評鑑成績不佳的學校將最先承受供需失調的苦果。從 2010 年的評鑑指標，教育部相當重視學生表現，正面導引各大學重視學生需求。目前，各大學陸續建立學生回饋機制以回應評鑑的要求，而經由這些回饋，使學校在教學設計與支援活動更能符合學生需求與未來發展的需要。

表 1　2009 年四技二專招生名額與錄取人數統計

入學方式	招生名額(含外加名額)	報名人數	錄取人數	不足額人數
四技二專總計	181,487	233,342	141,628	39,859
日間部計	139,116	190,194	111,589	27,527
四技二專聯合甄選委員會－推甄	43,157	73,280	32,761	10,396
四技二專聯合甄選委員會－技優	10,144	15,167	6,077	4,067
四技二專日間部聯合登記分發委員會	74,140	68,069	57,920	16,220
四技日間部高中生申請入學聯合招生	11,675	33,678	14,831	-3,156

資料來源：技專校院招生策進總會 http://www.techadmi.edu.tw/

然而，這些常規式的回饋機制通常僅限於教師職能方面，如教學評鑑與導師輔導工作的評核，鮮少觸及學校行政人員、教學設施和行政工作上。不過，在大學教育全面普及化之後，除了維持教師授課的權威性外，其經營必須引入服務業顧客至上的態度，以企業經營的角度滿足顧客需要。所以，學校經營者、管理階層與教師都應該瞭解學生對學校所提供之服務的評價和對整個學校的滿意度。本研究就是以此爲研究主題，並討論其間的關聯性。

關於服務品質的衡量，PZB(Parasuraman, Zeithaml & Berry(1985, 1988)和 Parasuraman, Zeithaml & Berry(1991))提出以有形性、關懷性、可靠性、反應性和保證性五構面建立 SERVQUAL 量表，包含 22 題目評量顧客對服務品質的認知與期望間的差異。Cronin & Taylor(1992)使用 PZB 的 22 題衡量服務品質，但是認爲調查顧客認知的服務品質已經足夠衡量服務品質，不需要調查期望的服務品質，而稱他們的方法爲 SERVPERF。接續很多研究指出 SERVPERF 確實具有較高的解釋能力(Babakus & Boller(1992)，Cronin & Taylor(1994)，和 Brady, Cronin & Brand(2002))。因此，本研究僅調查本校學生對學校服務品質的認知，利用探索式因素分析建立本校服務品質構面。再使用 LASSO 模型篩選法，分析影響學生滿意度的重要因素。進一步分析學生是否感受到學校持續進步，探討哪些服務品質構面是進步的，對於提升學生滿意度有影響。

本文以後各節安排如下：第二節爲文獻探討，回顧有關學校服務品質的重要研究與近幾年有關模型篩選(model selection)的發展。第三節說明本調查的問卷設計過程與抽樣方法，分析調查結果的信度。第四節爲利用探索式因素分析，建構本次服務品質的因素構面。第五節探討影響學生滿意度的重要因素，將服務品質變數依重要性排序。第六節爲結論，建議本校服務品質改善的重點，以及後續研究的課題。

貳、文獻探討

一般都認爲學生滿意度和學生成就存在有雙向的因果關係，Pike(1991)的研究認爲學生滿意度對學生成績有較強的影響，換言之，學校強化學生滿意度將能使學生的學習成就有較好的表現。以服務業的概念經營學校，不僅有助學生滿意度提升，利於學校招生(LeBlance & Nguyen(1999))，也利於學生的專業成長。最近 10 年，學校經營的壓力愈

來愈大，關於學生滿意度的課題受到很多研究人員的重視。黃勇富、李珮瑜、林玉芬、林佳慧、蕭雲玲(2000)以朝陽科技大學企管系學生爲對象，研究教學品質的缺口分析。李維靈，洪啓東，劉惠慈(2006)以建國科技大學學生爲對象，將該校服務品質分成可靠性、溝通性、內容性與安全性，利用 t 檢定判定學生期望與認知服務品質間是否有明顯差異，再以逐步迴歸建立服務品質與學生滿意度的關係，第一個被選入的構面爲服務內容，包含學校空間圖儀設備等，最後被選入的構面爲溝通性。鄧維兆和李友錚(2007)研究綜合七所私校的服務品質，仍以 PZB 模型探討學生之期望服務品質與認知服務品質間的差距，也是利用 t 檢定判定此差距在各構面都是顯著的，其中有形性是學生期望最高的構面，而關懷性是學生感受最低的構面。鄭靖國和王明忠(2007)經由文獻探討，進一步歸納出八個影響學習滿意度的構面，爲行政事務、課程與教學、學生輔導、環境設備、校園氣氛與社交、學習成就的滿足、餐飲服務以及學習壓力。以上這些都以 PZB 的 SERVQUAL 量表建立問卷調查方法。江民瑜(2007)以結構關係模型建構影響學生滿意度的模型，包含教育期望，教職員服務品質及學習成果。就如 Pike(1991)的研究，學習成果與滿意度有雙向關係，而劉宗哲(2006)認爲以服務業的角度，影響學生滿意度的因素是多面向的，對於學生滿意度的評估方向應該擴及整體校園經驗，而非只著重於教學品質的衡量。他認爲學校的企業形象對學生滿意度並無影響，只有改善學校的服務品質才能增進學生滿意度。綜觀上述研究，改善學校服務品質是一個持續性的過程，影響學生滿意度的重要因素往往各校不同。李水彬(2009a)調查清雲科技大學的學生對各項服務品質的評價，其中以教師專業與導師輔導最高，而行政人員的服務評價最低。李水彬(2009b)用同一份調查數據，將學校服務品質分成(1)教師職能、(2)學校關懷、(3)就業服務、(4)校園設施、和(5)行政人員等五個構面。將學校服務項目依品質之低、中和高三個等級區分，不論服務品質高低，都對滿意度有影響。

以上文獻探討確認學生滿意度是服務品質的函數，即具有迴歸關係，可經由改善服務品質提升學生滿意度。然而，改善必須有重點有先後次序，我們將以模型篩選方式探討影響學生滿意度的重要因素，討論過去學校的改善作爲是否符合學生的期待。模型篩選通常令損失函數(loss function)爲對數概數函數(log-likelihood function)再加上一個懲罰函數(penalty function)，利用電腦遞迴求解得到使損失函數最小的解。這個懲罰函數是一個迴歸係數的函數，具有使迴歸係數縮小(shrinkage)靠近零的作用。假設 $\hat{\beta}_1,\cdots,\hat{\beta}_p$ 爲 p 維解釋變數的迴歸係數，常用的懲罰函數爲迴歸係數的平方和函數(稱爲 L2 懲罰函數)，表示爲

$$P_R\left(\hat{\beta}_1,\cdots,\hat{\beta}_p\right)=\lambda\sum_{i=1}^{p}\hat{\beta}_i^2 \quad , \tag{1}$$

此種懲罰函數的迴歸係數解稱爲 Ridge 迴歸，λ 爲懲罰係數，當 λ 值越大，$\hat{\beta}_i$ 值會越接近 0。若 $\hat{\beta}_k$ 值爲 0，表示第 k 個變數被排除在模型外；反之，若 $\hat{\beta}_k$ 值不是 0，表示第 k 個變數被選入模型內。由於 Ridge 迴歸將迴歸係數縮小，無法自動令不重要的變數的係數爲零，使得 Ridge 迴歸無法得出一個容易解釋的模型。另外，因爲變數間具有相關性，使得不重要變數的估計會影響重要性的判斷。Tibshirani(1996)提出用迴歸係數的絕對值的和爲懲罰函數(稱爲 L1 懲罰函數)，表示爲

$$P_L\left(\hat{\beta}_1,\cdots,\hat{\beta}_p\right)=\lambda\sum_{i=1}^{p}\left|\hat{\beta}_i\right|\ , \tag{2}$$

稱爲 LASSO(least absolute shrinkage and selection operator)方法。這個方法的特點就是可以讓一些變數的係數縮小爲零，使得模型解釋變得比較容易。Efron, Hastie, Johnstone & Tibshirani(2004)提出最小角迴歸(least angle regression，簡稱LARS)模型演算法，可以減少LASSO解的電腦計算時間。Park & Hastie(2007)將L1懲罰函數應用泛線性模型(generalized linear model)的模型選擇上。Friedman, Hastie & Tibshirani(2010), Tibshirani , Bien, Friedman, Hastie, Simon, Taylor & Tibshirani(2010)和 Simon, Friedman, Hastie & Tibshirani(2011)研究 L1 懲罰函數在泛線性模型的求解，寫成glmnet函數庫，可於 R-project[1] 軟體上執行。

本研究將學生滿意度表示成服務品質變數的羅輯斯迴歸爲一個泛線性模型，利用R-project的glmnet函數庫進行模型篩選，羅輯斯迴歸模型的迴歸係數可以解釋服務品質對學生滿意度的效應，決定重要的服務品質變數與構面，提供學校進行服務品質改善的重要參考。

參、問卷設計與抽樣

一、 問卷設計

此份問卷於 2008 年開始設計，以 6~8 人不等將選修抽樣分析課程約 60 位同學分成數組，於課堂中每組以腦力激盪法提出問卷題目，經過彙整排除幾乎相同的題目後共有 66 題不同的題目。再利用 PZB 的 5 個服務品質構面和新品管七大手法之一的親和圖，將學生提出的問題予以歸類，設計出一份服務品質問卷初稿。預抽工管系各年級約 40 位同學，請受訪者填答問卷並對問卷主題，敘述方式是否混淆提供建議，分析每題的分配是否過於集中於某一個選項，將問卷略作修正後方做正式調查。經過兩年兩次調查實證後，設計出服務品質的題目如表 A.1(參見附錄)與數題學生滿意度的問題，以後稱每一問題爲一個變數。問卷中亦包學生經濟行爲與生活型態的調查，在此論文中略去。

表 3　各學院和各年級的有效問卷數

學院\年級	一年級	二年級	三年級	四年級	合計
電資學院	35	27	30	31	123
工學院	20	19	19	17	75
管理學院	30	27	27	23	107
商學院	21	20	21	19	81
合計	106	93	97	90	386

[1] 可於 http:\\www.r-project.org 免費下載使用。

二、 樣本與抽樣方法

本次抽樣調查設定精確度爲信心水準95%下，抽樣誤差小於5%。本校日四技學生總數爲 $N=7547$，有效樣本至少爲 366 位受訪者。本校有四個學院，14 個系共 132 個班級，實際執行抽樣上，以簡單隨機抽樣在各班學號名單上抽出 3 位，利用電子郵件通知受訪者填寫網路問卷，再對沒有回應的同學發放實體問卷，總共得有效問卷爲 386 份，有效問卷的配置如表 3 所示。問卷調查成功率約爲 98.5%。

三、 信度分析

根據李水彬(2009b)的問卷調查，學校服務品質分成:(1)教師職能，(2)學校關懷，(3)就業服務，(4)校園設施，(5)行政人員等五個構面。相同構面的問題具有相同性質，受某一個潛在因素的影響，因此將其視爲對受訪者的重複量測。倘若受訪在這個構面上回應具有一致性，則共變異數占總變數的比例會很高，此比例稱爲 Cronbach's α 係數。本次問卷各構面的信度列於表4，都超過 Nunnally(1978)所建議的0.70，根據吳統熊(1985)的信度等級判定，本問卷各構面皆爲第 2 的可信等級。

表 4 各個構面的 α 係數

問卷構面	題目數	題目編號	α 係數
教師專業	5	01~05	0.79
行政支援	6	06~11	0.80
學校關懷	4	12~15	0.70
就業服務	3	16~18	0.80
硬體設施	7	19~25	0.84

肆、服務品質的構面分析

一、學生對學校服務品質的評價

令 X_{ik} 代表第 i 位受訪者在第 k 題上的意見，正面意見者得 1，以下稱贊成；其他選擇者給 0，以下稱不贊成。其定義如下：

$$X_{ik}=\begin{cases}1, \text{非常贊成, 贊成}\\ 0, \text{無意見, 不贊成, 非常不贊成}\end{cases}$$

各題贊成的比例依全體學生，學院和年級列於表 A.2。表格中標示◎表示該題的服務品質評價排名前三，符號▲表示該題的服務品質評價排名爲倒數三名。不論以全校、學院、年級層面來看，共通點都爲教師與學校關懷的滿意度較高，硬體與行政方面較低。以全校而言，服務品質評價前三者爲 X1、X12 和 X14，代表學生對教師專業和輔導，以及學校推動校園安全教育的肯定，與本校助理教授級以上教師比爲 78%和博士級以上教師

爲 73%都優於私立科技大學的平均水準[1]，以及最近幾年配合教育部政策，積極推動校園地震消防演練與性騷擾防治等工作有關；排名最後三名 X7、X8、X9、X10[2]、X21，又以選課系統優良能夠順利選到課(X7)與學校有充足的機車停車位(X21)的贊成比例最低。不滿意的共通點如下：

1. 學生選課系統的服務品質最差。每學期都有不少學生抱怨選不到課，必須熬夜等待選課系統開放，選課系統流量不足導致掛網等原因，以致於學生對現今選課系統服務品質感到不滿意。
2. 機車停車位不足。李水彬(2009b)的調查，這題贊成比例不及 20%。學校在 2009 年大幅增加停車數量後，雖然贊成比例仍低，但已經有顯著提升。這也顯示學校的改善作爲受到學生的重視，給予正面的回饋。比例仍低的原因，可能是對新增室外停車點無法遮風擋雨所致。
3. 行政服務仍有進步空間。本校學生對於行政人員提供的服務似乎不太滿意，包含人員的態度，文件與手續。原因可能是在一些申請手續太過繁雜，對於鮮少申請的學生，不易理解加上服務人員的表達方式可能無法使學生清楚了解流程；再來就是處理的工作天過長，使學生對於行政處理方面的滿意比例低。學校可以從行政人員的教育訓練著手，改善文件說明的表達方式與標示學生案件處理期限等管理方式改善學生對行政支援的評價。

依年級或學院區分，贊成比例殿後的排名並無明顯差異，但在贊成比例前三名則略有差異，這些差異反應出目前學校政策推動受到主要學生群體的肯定。例如：

1. 商學院學生對學校校園安全教育(X14)的贊成比例約 77%高於全校平均 68%，可能因爲本校商學院學生女生比例約 81%，比較重視校園安全方面，而學校的宣導活動也讓學生注意到了。
2. 導師輔導(X12)的贊成比例以一年級最高，但有逐年遞減的趨勢。事實上，就學生的輔導需求也是如此，一年級新生剛進學校對於很多事情不明白需要導師的關懷與協助，而本校導師也做到符合學生的需求。而二、三、四年級因慢慢習慣學校生活，導師的重要性相對於其他項目就下降了，但仍有很高的比例表示肯定。
3. 二年級學生開始面對一些專業性的課程，學校設計多面向的課後輔導機制，主動輔導學習表現不佳的學生。任課教師必須瞭解學生間的差異性，適時給予關懷，而二年級的學生對這項教學服務品質(X13)滿意度最高，贊成比例達 76%。另外，任課教師有充分的專業知識回答學生的問題(X1)的滿意度達 74%和任課老師對於學生諮詢能迅速且的回應(X5)的滿意度達 74%，皆爲次高。因爲各系二年級的核心課程都從二年級開始，需要更多的課業輔導措施給予協助，而本校在這方面的努力確實受到學生的肯定。
4. 本校對於三年級學生開始推動專業證照輔導，各系設計 3 至 4 門乙級專業證照輔導課程，補助報名費與提供證照獎學金，提高考取證照的比例，讓學生往後就業機會更多。所以，本研究調查顯示三年級對於學校重視學生證照輔導並定期發佈證照相關資訊(X16)的滿意度最高，達 73%。

以上的例子顯示兩點：(1)本校過去結合教育部卓越計畫強化導師功能、落實課後輔導、學業導師、教學助理、鼓勵學生考取證照等，獲得學生普遍的肯定。(2)由調查問卷

[1] 根據本校 99 年科技大學大學評鑑資料
[2] X8,X9,X10 三題贊成比例相同

符合上述努力預期的結果，表示本問卷除了具有信度外，也具有效度，接續的分析結果值得作爲本校持續改善的參考。

二、 服務品質的構面分析

在討論服務品質與學生滿意度的關係之前，首先利用探索式因素分析將服務品質變數的 5 等第給分歸納成幾個構面。在因素分析上，一個很重要的問題就是決定因素個數與因素解釋，兩者互有關聯。有關因素個數的決定，通常有兩種角度，第一種是以統計顯著性檢定作爲基準，另一種是以變異解釋量作爲基準。Tinsley &Tinsley(1987)指出使用統計顯著性檢定，在受訪者人數很多的情況下，容易判定一些不重要的因素是顯著的，這也是統計顯著性檢定常存有的問題。實務上，我們建議以變異解釋量作爲基準，最簡單的方法爲 Kaiser 準則，假若因素的變異(特徵值)解釋大於 1 或稱貢獻大於 1，表示這個因素對變異的解釋力大於單一變數，故將此因素保留下來。另一種爲 Cattel's Scree 檢定，將各因素解釋量由大至小，由左而右繪製成一條遞減曲線，通稱爲 Scree 圖。以視覺方法判定曲線最大的曲折變化點(inflection point)，往往發生在曲線陡降後轉成水平之轉折處，此轉折處左邊的所有因素都是具有解釋力的因素，此轉折處右邊的因素則被認爲是隨機干擾造成的。如圖 3，紅色曲線爲本校服務品質的 Scree 圖，前 5 個因數的特徵值大於 1，依 Kaiser 準則選定因素個數爲 5。依 Cattel's Scree 檢定，第 3 個因素之後的特徵值變化小，接近水平曲線，故應選因素個數爲 2。

除了上述兩種外，Humphrey-Ilgen 平行法是一種避免受訪人數多寡和變數個數影響的方法。假設我們隨機用電腦生成樣本大小爲 n 的 p 維變數的資料。假設這些變數是不相關的，這 p 個變數不存在因素構面。然而分解其相關性矩陣一定可以得到幾個特徵值大於 1，這說明特徵值大於 1 也可能是隨機干擾造成的。所以，平行法以樣本分配隨機生成與實際數據相同樣本大小的數據，例如有 386 位受訪者在第 1 題選項 1 至 5 的次數分配爲(10, 33, 145, 136, 62)，根據此比例生成此題的模擬數據。因爲每一題的模擬數據是獨立生成的，所以整筆模擬數據不具有因素構面。圖 3 黑色爲模擬數據的 Scree 曲線，紅色爲實際數據的 Scree 曲線。紅色點高出黑色 Scree 曲線的因素，被認爲具有解釋力因素。因爲兩線交點在因素 3 和因素 4 間，可以選三個或四個因素。然而，在相關性矩陣之特徵值總和必爲 p 的限制下，Humphrey- Ilgen 平行法可能有低估因素個數的問題。

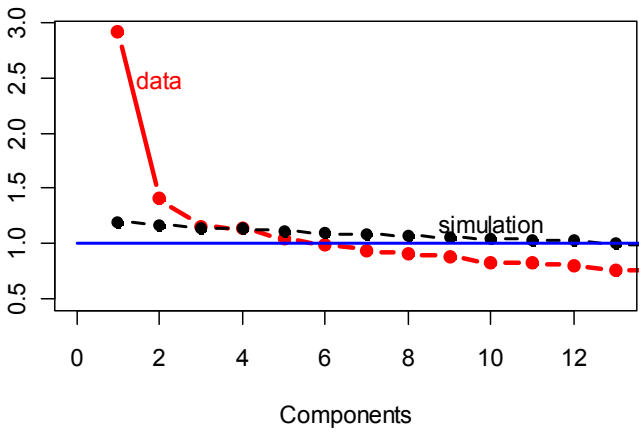

圖 2 Scree 圖與 Humphrey- Ilgen 平行法

以上這些方法，都以單一因素的解釋量爲選擇的基礎和 Scree 圖作爲選取因素個數的判斷。然而，這些方法的一致性並不高，本研究調查也呈現這樣的結果。Tinsley & Tinsley(1987)討論用 Scree 圖的問題，在沒有堅固的理論與經驗作爲基礎下，建議以因素解釋「總變異量」的百分比作爲因素選定的基準。強調應該多方考量，而非單獨使用一種準則來決定因素個數。

除了以因素解釋量作爲選擇的基礎外，我們必須注意到因素分析的重點在於解釋這些因素是否存在獨立的意涵。因此，我們嘗試將因素個數設定爲 4~7 個，使用 Varimax 轉軸後，決定選定因素個數爲 6，累積解釋變異量約爲 50%，因素負荷列於表 A.3。因爲大學教師對於學生扮演教學與輔導的兩項職能，故變數 X1 與 X3 在因素 1 和因素 6 存有交叉負荷 (負荷大於 0.4) ；另有幾題變數的最大負荷僅超過 0.3，但在前節分析中的滿意度明顯偏低，故仍予以保留。在不影響因素命名與解釋下，表 A.3 僅列出每一題最大的因素負荷。根據各因素包含的變數，我們將本校服務品質分成以下 6 個構面：

(1) 學校關懷：學校對同學需求的反應性，可靠性與關懷層面。
(2) 行政支援：涵蓋選課系統，行政人員的態度，一些申請文件與流程。
(3) 課後活動：本校學生在校園內除了到教室上課與運動外，在校園內的主要活動內容與範圍就屬圖書館與社團活動，故將此項因素命爲課後活動。
(4) 就業輔導：與同學畢業後發展有關的服務內容，包含證照考試與參與各種競賽的情形。
(5) 空間硬體：泛指學校空間，硬體設備與圖儀維修是否足堪使用。
(6) 教師專業：任課教師授課與專長是否足以提升學生專業能力。

此次調查與李水彬(2009b)比較，其中校園設施分成空間硬體與課後活動，而教師職能包含教學與輔導，而輔導這部分在此次調查中歸類爲學校關懷。各構面的信度列於表 5，都超過 Nunnally 所建議的 0.70，皆屬可信等級。

表 5　新構面的α係數

問卷構面	題目數	α係數
學校關懷	7	0.81
行政支援	5	0.78
課後活動	3	0.82
就業輔導	4	0.78
空間硬體	4	0.74
教師專業	2	0.78

伍、學生滿意度分析

一、模型假設

根據一些探討顧客滿意度的模型中，服務品質是滿意度的前置變數，也就是操控服務品質可以改變顧客滿意度，而滿意度的提升將可強化顧客忠誠度，形成正面的口碑效應。以學校經營的角度，若能由學生校友的口碑宣傳，將使學校的招生更爲順利。因此，我們要從學生對服務品質與滿意度的認知中，探討以下兩個問題：

(1) 哪一個因素對學生滿意度的影響最大？在服務品質六構面中，它們對學生滿意度的

影響如何？在前述的討論中，我們知道學生對學校行政支援與硬體設施等構面的評價較差，服務品質評價差的項目對於學生滿意度的影響比較大，或者不是？

(2) 以學生的角度，過去一年哪一個因素的改善最大？最近三年，本校獲得教育部逾億元的教學卓越計畫補助，更新很多軟硬體設施，鼓勵教師參加研習，引入校外專家意見從事課程規劃與協同教學等活動。使得超過 51%的受訪學生認爲學校比過去更有進步，只有 7%同學不贊同學校有進步，其他不表示意見。與李水彬(2009b)的調查比較，學生滿意度確實提高了約 10%，而學生所認知到的進步是根據哪些服務品質內容呢？

針對上述兩個問題，在此次調查中我們詢問受訪學生對以下兩個問題的意見。

問題 Y ：整體而言，我對學校感到滿意。

$$Y=\begin{cases}1, \text{ 贊成或非常贊成}\\ 0, \text{ 其他}\end{cases}$$

問題 Z ：整體而言，我覺得學校比去年進步。

$$Z=\begin{cases}1, \text{ 贊成或非常贊成}\\ 0, \text{ 其他}\end{cases}$$

令 $p_Y(X)$ 和 $p_Z(X)$ 分別代表在服務品質評價爲 X 的條件下，學生對學校感到滿意的比例與覺得學校比去年進步的比例。假設 $p_Y(X)$ 和 $p_Z(X)$ 與服務品質評價 X 的關係爲羅輯斯回歸模型(logistic regression model, 以下簡稱 LRM)，分別表式如下：

$$\text{logit}\left(p_Y(X)\right)=\log\frac{p_Y(X)}{1-p_Y(X)}=\beta_0^y+\beta_1^y X_1+\cdots+\beta_{25}^y X_{25} \tag{3}$$

$$\text{logit}\left(p_Z(X)\right)=\log\frac{p_Z(X)}{1-p_Z(X)}=\beta_0^z+\beta_1^z X_1+\cdots+\beta_{25}^z X_{25} \tag{4}$$

其中 β_0^y 和 β_0^z 爲模型的截距項，$X_i, i=1,\cdots,25$ 爲本研究調查中的 25 題服務品質變數，其斜率參數用 β_i^y 和 β_i^z 表示之，代表第 i 個服務品質變數(X_i)評價增加 1 個等第，反應在對數勝算比上的變化量，斜率參數爲正表示該變數提升可以增加學生滿意度。

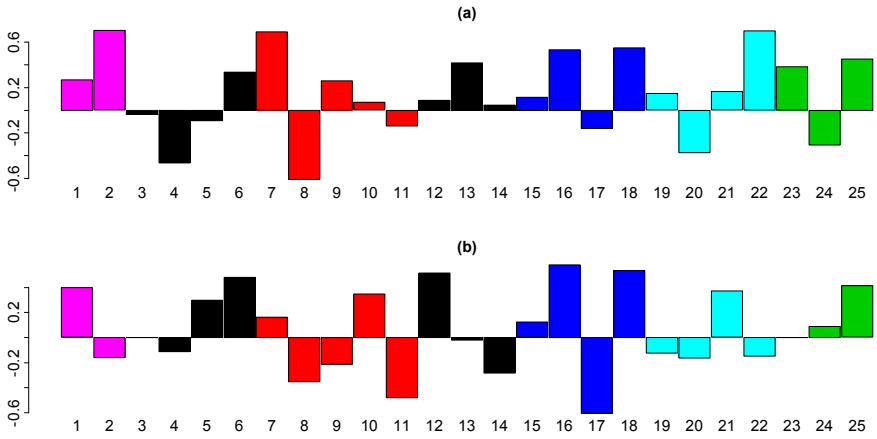

圖 3 全模型參數估計之貢獻圖

因爲這些服務品質變數據有共線性，特別是同一個構面的變數間有很強的相關性，因此，當我們配適所有變數的 LRM 時，有些變數的斜率參數是負值，如圖 3(a)爲配適學生滿意度變數(*Y*)與服務品質變數的迴歸係數貢獻圖，圖 3(b)爲配適學校是否進步的變數(*Z*) 與服務品質變數的迴歸係數貢獻圖，顏色區分變數所屬因素構面。有些變數係數爲負值，似乎顯示改進這項服務品質變數反而使得學生滿意度下降，或讓學生反而覺得學校沒有進步，這樣的解釋顯然難以成立。事實上，這種沒有經過篩選變數的全模型之迴歸係數並無法解釋與協助我們理解這個變數對學生滿意度的效應。所以，我們要利用模型篩選方法配適出一條具有可理解性的回歸模型。

二、影響滿意度的重要因素

就一般可理解的觀念，當受訪者認知某項變數有較高的服務品質時，其對學生滿意度應有正向的影響，迴歸係數不能爲負值，而迴歸係數的大小可解釋該項服務品質對學生滿意度的重要性，利用迴歸係數的值可排序出影響影響學生滿意度的重要性。這裡必注意一件事，在配適 LRM 時，假設服務品質的數據尺度爲區間尺度(interval scale)，有些研究者稱爲準區間尺度，以迴避統計分析上的一些問題。但事實上，問卷調查的數據爲等級尺度，或稱順序尺度(ordinal scale)，故本研究解釋迴歸係數時僅考慮其順序而不強調回歸係數值間差異的程度。實務上，用順序表現服務品質的重要性已經足以提供學校改善的方向。如圖 4 左圖爲式(3)的模型篩選路徑圖，當式(2)的懲罰係數 $\lambda = 0.025$ 時可以選入 12 個變數且係數皆爲正值。依係數大小排名決定影響學生滿意度重要性依序爲

$$\underset{(0.43)}{X_2} > \underset{(0.43)}{X_7} > \underset{(0.39)}{X_{22}} > \underset{(0.25)}{X_{16}} > \underset{(0.25)}{X_{18}} > \underset{(0.21)}{X_{25}} > \underset{(0.21)}{X_{13}} > \underset{(0.20)}{X_{23}} > \underset{(0.16)}{X_1} > \underset{(0.11)}{X_6} > \underset{(0.02)}{X_{21}} > \underset{(0.01)}{X_9} \qquad (5)$$

上式括弧內爲變數的係數估計值。影響學生滿意度的最重要因素爲 X2 代表學校的師資是否優良，屬教師專業構面；排名第二名爲 X7 爲選課系統，可見學生非常重視是否可以順利選到自己喜歡的課程，屬行政支援構面；排名第三名爲 X22 爲學校的教學設備新穎且定期維護，屬空間硬體構面。排名第四、第五爲 X16、X18 屬就業輔導構面；排名第六爲學校圖書資源，屬課後活動構面；排名第七爲 X13 屬學校關懷構面。總計前七名包含全部六個構面，僅有就業輔導構面有兩個變數。這裡必須強調利用 LASSO 模選方法，只能用在具有效度的問卷上，一份不具有效度的問卷可能使 LASSO 只能選出非常少的變數，甚至影響最大的係數也是負值。在前節分析學生對服務品質評價，證實這份問卷是具有效度的。另外，因素分析將具有高度相關的變數框架在同一構面中，因此，當構面中最重要的變數被選入模型後，其他變數與它有高相關就不易再被模型選入，因爲其對學生滿意度的解釋力大部分已經被選入變數所表達。對應表 A.2 服務品質贊成的比例，重要性排名第二的選課系統的評價最差，以品質改善的觀點，改善選課系統應是首要。雖然，停車空間 X21 與行政申請文件 X9 的服務品質也很低，但對滿意度的影響較小。

表 6 各構面選入變數與重要性

問卷構面	變數	係數和
學校關懷	X6, X13	0.32
行政支援	X7, X9	0.44
課後活動	X23, X25	0.41
就業輔導	X16, X18	0.50
空間硬體	X21,X22	0.41
教師專業	X2, X1	0.54

如表 6 的整理，各構面都有兩個變數被選入模型之中，我們以選入變數的係數和作爲判定該構面的重要性。得到如下的關係：

教師專業> 就業輔導> 行政支援> 空間硬體=課後活動> 學校關懷 (6)

大學生就學之主要目的爲獲取專業知識，畢業後可以順利找到工作，教師專業與就業輔導的重要性排在前二名，應是合理的結論。本校非常重視學生的照顧，但是學校關懷構面卻排名最後，顯然與學校努力的預期有些不同，但與李維靈等人(2006)的研究結論相同。從實際執行導師工作的觀察，這樣的結果還算是合理。導師輔導是極爲重要的，但非全面性的。對大部分同學而言，導師工作主要是執行學校交辦事項，關心同學出缺席情況而已；而僅有少數同學需要導師引導溝通。

至於服務品質評價是否影響其對滿意度的重要性，可從比較式(6)的重要性排序與表 A.2 看出其間沒有明顯的關聯性存在，也就是學生服務品質的認知，並不會影響其重要性，這與李水彬(2009b)用不同的統計方法得到的結論相同。

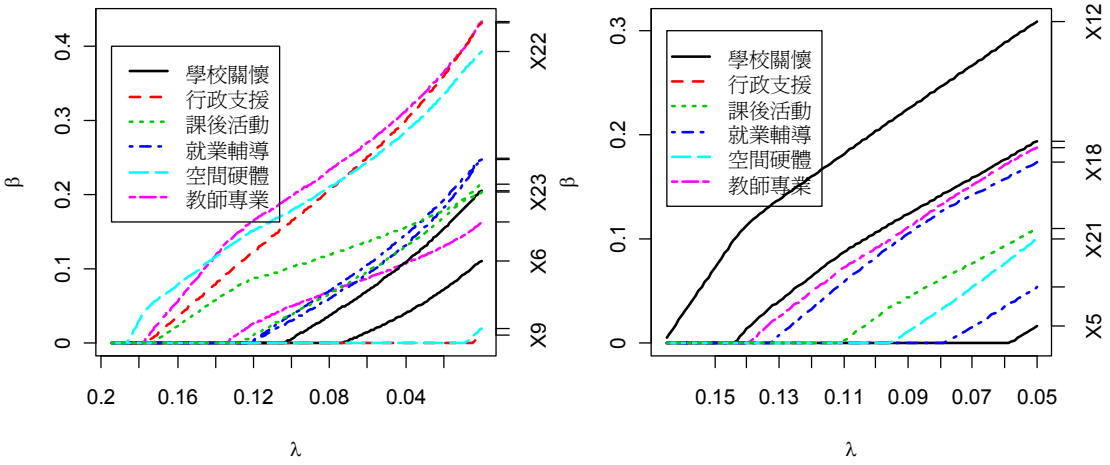

圖 4 模型篩選路徑圖

三、進步最多的服務項目

此節我們續利用 LASSO 選模探討過去一年本校服務品質改善最多的項目。圖 4 右圖爲配適式(4)之 LRM 的模型篩選路徑圖，當式(2)的懲罰係數 $\lambda = 0.035$ 時可以選入 8 個變數且係數皆爲正值，依序爲

$$\underset{(0.31)}{X_{12}} > \underset{(0.19)}{X_6} > \underset{(0.19)}{X_1} > \underset{(0.17)}{X_{18}} > \underset{(0.11)}{X_{25}} > \underset{(0.10)}{X_{21}} > \underset{(0.05)}{X_{16}} > \underset{(0.02)}{X_5} \quad (7)$$

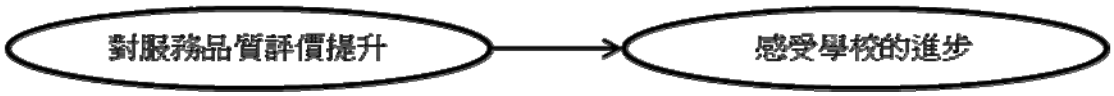

圖 5　服務品質評價與感受學校進步的關聯圖

我們假設如果服務品質沒有改善，則受訪學生不會感受到學校的進步；而感受到學校比過去進步的原因是由於學校改善某些服務品質所導致的，提升任何一項服務品質都會使學生感受到學校的進步，如圖 5 的示意圖。舉例來說，X12 導師會適時輔導或幫助學生的係數最高，表示給 X12 高服務品質的學生認爲學校有進步的比例比給予低服務品質者爲高。學生感受到學校在導師工作的進步，所以給 X12 較高的評價。比較李水彬(2009b)的調查報告，整體而言學生對學校滿意的比例從 41.4%提升至 51%。滿意 X12 的服務品質由 52.9%提升至 68%。滿意 X6 學生資訊系統的比例由 43.2%提升至 62%，而本校於 2010 年評鑑前方建置完成 SIP 學生資訊系統，所以對該項服務品質的提升是合理的。由於教學卓越計畫補助，每系至少三門證照輔導班，並給予報名費補助與證照獎學金，使得 X16 由 35.2%提升至 62%；又如本校於 2009 年承租可納數千輛機車的停車位，使停車位滿意度由 18.2%提升至 35%。除了變數 X5 外，排名前 7 個變數都是式(3)模型的解釋變數。換言之，學校努力提升服務項目對學生滿意度都有重要影響。

就服務品質構面比較，我們以選入變數的係數和作爲判定該構面進步的程度如表 7。依係數和大小排成式(8)的進步幅度順序。式(5)和(6)的重要性排序和式(7)和(8)的進步排序呈現一些不一致之處。譬如，本校非常強調導師輔導的機能，學生也認爲學校在關懷層面進步最多，在前節服務品質評價上也最高，但是其對學生滿意度的影響卻是最低的。行政支援構面並無變數被選入，學生認爲學校在這方面的努力仍嫌不足，所以在前節服務品質評價上行政支援對低，然對滿意度的重要性僅次於教師專業和就業輔導。此外，學生認爲 X22 最重要，但 X22 並不列入式(7)中，由同學回應意見顯示學校對於儀器設備的維護仍需加強。

表 6　各構面選入變數與重要性

問卷構面	變數	係數和
學校關懷	X5, X6, X12	0.52
行政支援	無	0.00
課後活動	X25	0.11
就業輔導	X16, X18	0.22
空間硬體	X21	0.10
教師專業	X1	0.19

學校關懷> 就業輔導> 教師專業> 課後活動> 空間硬體> 行政支援　(8)

陸、結　論

本研究採用 SERVPERF 服務品質評量方式衡量本校各項服務品質，依調查結果顯示，在學校的服務內容中，學生對教師與學校關懷方面的滿意度較高，空間硬體與行政方面的評價較低，特別是在選課系統，機車停車位與行政支援等方面要特別努力。在分析各年級與各學院的差異，一方面證實學校過去進行服務品質改善的作為受到學生的肯定，也間接說明本問卷具有一定的效度。

以服務業經營的角度，學校對服務內容的品質改善若能與學生滿意度產生正向關係，將有助於提升學校的競爭力。因此，本研究利用探索式因素分析，將服務品質變數分成六的構面，包含教師專業、學校關懷、空間硬體、課後活動、行政支援與就業輔導。以 LRM 描述學生滿意度與服務品質的關係，利用 LASSO 模型篩選法，判定影響學生滿意度的重要服務內容依序為教師專業、選課系統與教學設備。而學生對學校服務品質的評價與該項服務的重要性無關。若以服務品質構面分析，則以教師專業，就業輔導和行政支援最為重要。然而，學生認為過去一年學校在學生關懷的構面進步最多，而在行政支援的進步最少，而事實上在服務評價上行政支援的滿意度是最低的。這裡點出學校應該著手改進選課系統、改善行政人員的服務態度，讓與學生相關的申請作業流程更為清晰易於瞭解。此外，學生非常重視教學設備的維護品質，能夠使教學活動順利進行。

本研究是以全校的範圍討論有關影響學生滿意度的重要因素，但就各年級與各學院對服務品質評價存有差異，意涵這些重要因素可能有年級與學院間的層別效應。另外，影響學生滿意度的因素除了考量服務提供者的服務內容外，學生本身的特質應該是一項重要因素，不同背景的學生對大學求學生活的預期與期待可能有差異，這些差別可能影響她(他)對學校滿意度與服務內容的要求，這些都是本研究之後續研究的主題。

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附 錄

表 A.1 清雲科技大學學生滿意度問卷題目

清雲科技大學之學生滿意度調查

項次	題 目
X1	任課教師有充分的專業知識回答學生的問題
X2	學校的師資優良
X3	任課老師上課不會遲到早退
X4	老師辦公室時間不會找不到
X5	任課老師對於學生諮詢能迅速的回應
X6	學生資訊系統的功能符合學生需求
X7	選課系統優良能夠順利選到課
X8	行政人員對其所負責的業務能提供詳盡的服務
X9	學校行政單位的服務項目與申請文件淺顯易懂
X10	學校各項業務辦理手續都具備省時便利
X11	行政人員會定期發佈學校最新資訊
X12	導師會適時輔導或幫助學生
X13	任課教師瞭解學生間的差異性，適時給予關懷
X14	學校有在校園安全教育（交通安全、性騷擾性侵害防治、校外租屋法律、防震 防災教育）做宣導
X15	學校提供足夠的工讀機會
X16	學校重視學生證照輔導並定期發佈證照相關資訊
X17	學校充分的提供升學輔導與諮詢
X18	學校會鼓勵學生參加校外活動、競賽
X19	學校有充足的運動設施
X20	學校有充足的教學設備
X21	學校有充足的機車停車位
X22	學校的教學設備新穎且定期維護
X23	學校圖書館有豐富的學習資源
X24	學校圖書館有便利的網頁提供搜尋服務
X25	學校有豐富且多元的社團活動

表 A.2 服務品質贊成的比例

題目編號	全部	學院				年級			
		電資	工	管理	商	一	二	三	四
X1	0.68◎	0.70◎	0.64◎	0.68◎	0.70	0.65	0.74◎	0.68◎	0.67◎
X2	0.65	0.66	0.53	0.71◎	0.67	0.59	0.67	0.71◎	0.63◎
X3	0.59	0.58	0.59	0.59	0.63	0.55	0.57	0.68◎	0.58
X4	0.54	0.63	0.53	0.49	0.48	0.51	0.61	0.55	0.50
X5	0.66	0.72◎	0.57	0.60	0.72◎	0.68◎	0.74◎	0.60	0.60
X6	0.62	0.59	0.68◎	0.57	0.68	0.65	0.67	0.64	0.52
X7	0.33▲	0.48	0.32▲	0.21▲	0.27▲	0.32▲	0.35▲	0.30▲	0.34▲
X8	0.40▲	0.43▲	0.40▲	0.36▲	0.43	0.46	0.41▲	0.40▲	0.33▲
X9	0.40▲	0.42▲	0.43	0.38	0.38▲	0.41	0.44	0.40▲	0.37
X10	0.40▲	0.46	0.43	0.36▲	0.33▲	0.38▲	0.49	0.40▲	0.32▲
X11	0.59	0.59	0.63	0.56	0.60	0.62	0.61	0.59	0.53
X12	0.68◎	0.76◎	0.61	0.62	0.73◎	0.72◎	0.71	0.68◎	0.62
X13	0.62	0.67	0.56	0.54	0.70	0.56	0.76◎	0.61	0.56
X14	0.68◎	0.65	0.65◎	0.66◎	0.77◎	0.69◎	0.73	0.68◎	0.61
X15	0.48	0.50	0.52	0.43	0.49	0.50	0.51	0.49	0.42
X16	0.64	0.67	0.56	0.65	0.65	0.60	0.63	0.73◎	0.60
X17	0.62	0.65	0.56	0.62	0.65	0.59	0.62	0.67	0.61
X18	0.61	0.66	0.48	0.64	0.63	0.65	0.56	0.61	0.63◎
X19	0.47	0.49	0.48	0.45	0.48	0.50	0.45	0.52	0.42
X20	0.51	0.50	0.51	0.51	0.54	0.46	0.52	0.54	0.54
X21	0.35▲	0.38▲	0.33▲	0.28▲	0.40	0.36▲	0.30▲	0.37▲	0.36
X22	0.46	0.52	0.44	0.38	0.47	0.47	0.48	0.48	0.38
X23	0.53	0.56	0.52	0.50	0.56	0.58	0.54	0.56	0.46
X24	0.58	0.58	0.52	0.60	0.59	0.56	0.55	0.63	0.57
X25	0.51	0.55	0.51	0.49	0.49	0.49	0.57	0.48	0.51

(◎ 和▲ 代表在同一層別下，受訪者贊成比例最高與最低的前三題)

表 A3 學校服務品質之因素分析構面

題目	學校關懷	行政支援	社團圖書	就業輔導	硬體設備	教師專業
X1	---	---	---	---	---	0.586
X2	---	---	---	---	---	0.653
X3	0.486	---	---	---	---	---
X4	0.555	---	---	---	---	---
X5	0.594	---	---	---	---	---
X6	0.374	---	---	---	---	---
X7	---	0.388	---	---	---	---
X8	---	0.668	---	---	---	---
X9	---	0.728	---	---	---	---
X10	---	0.698	---	---	---	---
X11	---	0.386	---	---	---	---
X12	0.592	---	---	---	---	---
X13	0.592	---	---	---	---	---
X14	0.446	---	---	---	---	---
X15	---	---	---	0.361	---	---
X16	---	---	---	0.770	---	---
X17	---	---	---	0.627	---	---
X18	---	---	---	0.577	---	---
X19	---	---	---	---	0.446	---
X20	---	---	---	---	0.728	---
X21	---	---	---	---	0.313	---
X22	---	---	---	---	0.409	---
X23	---	---	0.746	---	---	---
X24	---	---	0.695	---	---	---
X25	---	---	0.562	---	---	---

機構投資人從事期貨交易之影響－台灣之實例

On the Effect of Institutional Investors Trading in the Futures Market —A Case of Taiwan

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摘　要

本研究旨在檢驗開放機構投資人從事期貨交易對於台灣股市之影響，資料期間涵蓋 2007 年 7 月 2 日至 2009 年 12 月 31 日的每日交易資料共 682 筆。研究程序包括，使用 ADF 單根檢定確認變數的時間序列資料型態的穩定情形，採用 Ljung-Box 檢定進行序列相關性驗證，以 Granger 方法實證因果關係檢定，最後進行向量自我迴歸模型的估計。研究結果顯示，研究使用的各變數間具互動關係。向量自我迴歸模型的估計發現，開放機構投資人從事期貨交易對於台灣股市並無顯著影響。

關鍵詞：機構投資人、期貨市場、期貨未平倉量、ADF 單根檢定、向量自我迴歸模型

Abstract

This article examines the effect that allowing institutional traders to invest in the futures market had on the Taiwan stock market. The study is based on daily trading records from 2 July 2007 to 31 December 2009—a total of 682 daily data sets. The research procedure involves identifying the stationality of a time series for each variable using the Augmented Dickey-Fuller unit root test, a serial correlation test with the Ljung-Box test, causality tests using Granger's methodology, and the estimation of a vector autoregressive (VAR) model. The results show that some of the variables under investigation are interrelated. In terms of estimating the VAR model, the impact that opening futures trade to institutional investors has had no significant effect on the Taiwan stock market.

Keywords: Institutional investors, futures market, futures open interest, ADF unit root test, vector autoregressive model

I. Introduction

Efficient market theory argues that market trading information is fully reflected in the current price. Hence, no-one can obtain a supernormal profit by analyzing past price patterns (Fama, 1970). Prior studies have suggested the predictability of asset returns with their trading rules based on technical analysis and time series, e.g. Brock et al. (1992), Mills (1997), Fang and Xu (2003), and Chang and Hu (2009). Yet are there, in particular, trading rules for share returns in Taiwan? Since the inception of the Taiwan futures market on July 21, 1998, the regulator has gradually opened futures trade to institutional investors. To promote information transparency, the Taiwan Futures Exchange (TAIFEX) has continuously released trading information on institutional investors, including the open interests of the top ten traders from July 2, 2004, and trading information on the three major institutional investor groups: qualified foreign institutional investors (QFII), security dealers (DEALER), and fund investment trust companies (INVEST), from July 2, 2007. Many studies on the stock market have considered institutional investors' trading information as a leading indicator. This article therefore attempts to investigate the effect that opening the futures trade to institutional investors had on the stock market.

Since numerous articles have provided evidence that the movements of open interest ratios signify both investors' confidence and their prospects (Lee, 2003 and Lai, 2004), the ratio probably contains information on the future state of the stock market. However, none of the empirical research thus far has investigated the effect of opening the futures market to institutional investment policies. Hence, by taking the long-short open interest ratios of the three major institutional investor groups from the futures market as a leading indicator, this article examines how its movements impact the stock market. It aims to answer the following two questions: (1) Do the futures open interest ratios of institutional investors hold a causal relationship with the spot market? (2) Through what dynamic structures do institutional investors trading in the futures market interact with the spot market? The empirical conclusions explicate whether the trading information from the various institutional investors qualifies as a leading indicator in the emergent stock market of Taiwan, and their exact interaction in practice.

Daily futures open interests on the three major institutional trader groups were collected from July 2, 2007 to December 31, 2009, along with the Taiwan Stock Exchange Value-Weighted Stock Index (TAIEX), in order to compute the daily open interest ratios and returns, with 682 daily records in total as data. The results show that of the three institutional investor groups, the open interest of the QFII affects TAIEX returns, though with only one-way causality; the DEALER's group, on the other hand, has two-way causality and not only affects, but is itself affected by, the TAIEX returns. In addition, the forecast error variance of the TAIEX returns at its current period is explained by the variable itself, as is the explanatory power of its 10 lag periods. This implies a high spontaneity of TAIEX returns, less affected by extraneous factors. However, whatever the open interests of QFII, DEALER and INVEST present low rates of explanatory power on TAIEX returns, such that the impact

of permitting institutional investors to trade in the futures market on the stock market is not significant.

This article makes two major contributions. It is the first study to assess the causality between the open interests of institutional investors and the stock market, and thereby to identify their dynamic structure in the emerging market of Taiwan. The second, a suitable application of research interests, is to incorporate the Granger causality test and vector autoregressive (VAR) model measuring the effect of government policy on the futures market, which serves as a useful methodology for related academic studies.

Section II of this article reviews the literature on the link between futures and spot markets. Section III constructs the Granger pair-wise causality test and the VAR model. Section IV presents the empirical results, and Section V presents the conclusions.

II. Brief introduction to TAIFEX and literature review

The TAIFEX has operated for over a decade since 1998, and has evolved in three five-year stages. The first stage aimed at pioneering and learning: the exchange opened for business and launched seven products. The two pioneering products were TAIEX futures, and TAIEX options. The second phase of development was dedicated to growth and breakthrough. This was an important milestone for TAIFEX as it broadened its scope to 11 products beyond the stock market, and made its product line more integrated. The product listing included both long and short interest rate futures, US dollar-denominated futures, over-the-counter index futures and options, non-electronic and non-finance sector index futures, and options rates. To ensure that market needs were being met adequately, the third stage undertook institutional reform and hedging functions. TAIFEX continuously introduced a number of new systems: daily disclosure of trading information on the three major groups of institutional investors; changes of initial-to-clearing and maintenance-to-clearing margin ratios; acceptance of multiple currencies, the introduction of a hedge account system for institutional traders; compensation of negotiable securities for margin deposits; extension of the SPAN margining system to end traders; revision of the final settlement date and simplifications in final settlement price calculations, and implementation of a TCP/IP network. It is now clear that the disclosure of trade information on the three major institutional traders is a crucial policy, and so this article aims at investigating the impact of this trade information on share returns and on revealing their dynamic interacting structure in the system.

Following the establishment of TAIFEX and the beginning of unrestricted dealing by institutional investors in the futures trade, a few studies have analysed the trading information on institutional investors as a crucial indicator for other investors. Huang (2005) focuses on futures open interests of large-order traders, considering them as a sensitive indicator for predicting stock index returns. Lee (2008) applies the daily futures open interests of the three major institutional investors in order to characterise their trading behaviours. He concludes that the behaviour of the INVEST group is that of a hedger, while the DEALER act as speculators, and the QFII have undetermined behaviour. The DEALER group has, however,

superior on-time profitability as compared with the two other groups. Chen (2009) investigates the influence of disclosing futures trade information of the three major institutional traders on market pricing efficiency, demonstrating that after the release of such trade information, the pricing errors were less than the pre-event pricing errors, meaning that market pricing efficiency increased. Chen (2008) argues that the availability of this futures open interest ratio information reveals the manipulative behaviours engaged in by the institutional traders and the large-order traders, and effectively predicts the stock market movements.

Part of the above research emphasises the order imbalance of the top ten traders, and the rest addresses the issue of whether disclosing futures trade information on the three major institutional traders affects market pricing efficiency. Nevertheless, thus far none of the empirical research reviewed has investigated the influence that the policy of opening futures trade to institutional investors had on the stock market. By constructing a more succinct, robust model and employing a longer study period to more effectively measure the impact of institutional investors' futures trading on the spot market, the results will indicate the significance of this policy and will confirm whether futures trade information should be considered as the leading indicator which research claims it to be. The conclusions may also serve as valuable information for a government making security market policy and related academic research.

III. Data and Empirical Models

1. Data Sources

In order to empirically analyse the cross-dependencies between institutional investors dealing in futures and the shares market, this article narrows the subject down by selecting futures open interests as an indicator and defining institutional investors as the three major institutional investor groups in the Taiwan securities market. These groups are the QFII, INVEST, and DEALER. The TAIEX returns stands as a proxy for share returns.

Although since March 17, 2007, three major institutional traders have dealt without constraints in futures market, the release of their trade information was deferred until July 2, 2007. For the purposes of this study, the data on futures open interest ratios of the three major institutional traders were retrieved from the TAIFEX based on the daily trading record from July 2, 2007 to December 31, 2009[1,2], a total of 682 daily records. The TAIEX was retrieved over the same period from the Taiwan Stock Exchange.

2. Variable measurement

When the open interest value (OI) from the futures market is treated as the base measurement, the long-to-short open interest ratio can be measured by

(Three_OI of buy position – Three_OI of sell position) / OI of the market

where Three_OI refers to the OI of three major institutional traders (Chang and Hu, 2009).

The share returns variable is measured by the volatility of the TAIEX, and can be calculated by

(Current period of TAIEX – Prior period of TAIEX) / Prior period of TAIEX)

where each period is one day; the current period is the current date, and the prior period is the day before the current date.

3. Empirical models

Whether or not the trading of institutional traders on futures market has a causal relationship with the stock market and their interactive structure, open interest is treated as an indicator of their impact on share returns. In order to achieving this, the empirical process involves the unit root test, serial correlation test, Granger pair-wise causality, and estimation of the VAR model.

(1) Augmented Dickey-Fuller (ADF) unit root test

It is necessary to identify the stationary state of each variable to obtain efficient results on the estimated time series models by applying the ADF unit root test (Said and Dickey 1984). Three different forms are considered:

(1) Test for unit root with no constant

$$\Delta y_t = \beta y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta y_{t-i+1} + \varepsilon_t \quad \text{..... (1)}$$

(2) Test for unit root with a constant

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta y_{t-i+1} + \varepsilon_t \quad \text{……..…… (2)}$$

(3) Test for unit root with a constant and a deterministic time trend term

$$\Delta y_t = \alpha + \gamma T + \beta y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta y_{t-i+1} + \varepsilon_t \quad \text{…….…….…… (3)}$$

where Δy_t is the differencing sequence; T is the time series trend term; k is the order of the optimal lag period in which residuals converge to a white noise sequence of $\varepsilon_t \overset{iid}{\sim} N(0, \sigma_\varepsilon^2)$.

The ADF test statistic is then calculated as

$$t = \frac{\beta}{s(\beta)} \quad \text{……..…… (4)}$$

When $t > t(n)$ (n the number of observations), or if p < 0.05, the null hypothesis is rejected and no presence of a unit root is found; otherwise a unit root is present.

(2) Serial Correlation

In determining whether the residual is a serial correlation, this analysis uses the LB-Q statistics test, developed by Ljung and Box (1978). If correlated, then the time series lagged effect is efficient. The LB-Q test statistic can be expressed as

$$Q_{LB} = n(n+2)\sum_{j=1}^{k}\frac{r_j^2}{n-j} \quad \text{.....(5)}$$

where r_j is the auto-correlated coefficient of the j^{th} lag period; n is the number of observations.

If $Q_{LB} > \chi^2(k)$ or if p < 0.05, then the null hypothesis of independence between the pre- and post-periods in the time series is rejected, indicating that the pre- and post-periods of the time series are not independent; otherwise they are independent.

(3) Granger causality test

To further check cross-dependence, the use of the Granger causality test (1969) determines the causality relationships between these four variables. In testing whether X causes Y, the null hypothesis is stated as "Y is not caused by X". The Granger causality model is defined as

$$Y_t = \sum_{i=1}^{p}\alpha_i Y_{t-1} + \sum_{j=1}^{q}\beta_j X_{t-j} + u_t \quad \text{.....(6)}$$

where u_t is the white noise, p is the order of the lag for Y, and q is the order of lag for X.

The *F* test statistic can then calculated as

$$F = \frac{(SSE_r - SSE_u)/k}{SSE_u/(n-2k-1)} \quad \text{.....(7)}$$

where SSE is the sum of squared residuals for the restricted and unrestricted regressions; n is the number of observations; and k is the number of parameters tested in the null hypothesis.

When either $F > F(k, n-2k-1)$ or p < 0.05, the null hypothesis of two sequences with no correlation is rejected, indicating there exists causality between x_t and y_t.

(4) The VAR model

The VAR model assumes that the set of variables under investigation are interrelated through their lag structure, and all variables in the system are endogenous (Sims, 1980).

The general VAR model is defined as

$$y_t = \alpha + \sum_{i=1}^{n} A_i y_{t-i} + \varepsilon_t \quad \text{.....(8)}$$

Such that $E(\varepsilon_t) = 0$

$$E(\varepsilon_t \varepsilon_t^{'}) = \Sigma \neq 0$$

$$E(\varepsilon_t \varepsilon_s) = 0$$

In equation (8), y_t is the $(n \times 1)$-dimensional vector of endogenous variables, with the character of a joint covariance stationary in a linearly stochastic process, and also relevant variables. ε_t is the $(n \times 1)$-dimensional vector of the forecast error, representing a shock, an innovation, or an impulse term. A_t is the $(n \times 1)$-dimensional conductivity matrix. $E(\varepsilon_t \varepsilon_t^{'}) = \Sigma \neq 0$ denotes that the concurrent error vectors between groups in simultaneous equations are correlated, while $E(\varepsilon_t \varepsilon_s) = 0$ indicates that each equation in the system of simultaneous equations is dependent on the time series.

The procedure for estimating a VAR model is briefly discussed, following Mills (1997). In order to find an appropriate order, k, a set of multivariate time series is jointly estimated for positive integer values of k, up to some maximum. Based on the estimated error covariance matrix of each k, the appropriate order AR(p) is chosen using the minimum AIC criterion (Engle and Yoo, 1987) . Once the appropriate order *k* is chosen, the VAR model is estimated using maximum likelihood estimation technique.

Compared to the Granger causality which only involves the lead-lag relationship between pair-wise variables, the VAR model constructs the impulse response function and forecast error variance decomposition to measure the interactive state between variables.

With the impulse response function, when one variable encounters a shock as a result of an exogenous change in the system, other related variables also show responses. The impulse response function estimates the dynamic effects between variables across periods of shock, and uses the number of periods affected to modify strategies.

Forecast error variance decomposition is used to capture the extent of the explanatory power of error variance in one variable, influenced by the variable itself and other related variables. It also assesses the relative significance of changes in other endogenous variables when one variable is affected by a spontaneous shock.

IV. Empirical Results

The empirical analyses include the unit root test, the serial correlation test, Granger causality, and the VAR model. Table 1 provides the basic statistics for each variable. The QFII open interest ratio is positive and reveals that its long position is higher than its short position, whereas those of DEALER and INVEST are negative, with their long positions being lower than their short positions. The series of the TAIEX returns and futures open interests of QFII, DEALER, and INVEST are all normally distributed in the Jarque-Bera statistic test.

Table 1. Basic statistics of variables

Variable	n	mean	Std. Dev.	Maximum	Minimum	Jarque-Bera
TAIEX returns	682	2.40E-05	0.018193	0.067422	-0.065133	42.39887
Open interest of QFII	682	0.111837	0.312474	2.446256	-0.938242	3091.312
Open interest of DEALER	682	-0.005416	0.135260	0.567653	-0.617790	356.7755
Open interest of INVEST	682	-0.130043	0.151590	0.064940	-1.576772	18635.00

Notes: 1.TAIEX returns is defined as the ratio change in stock index.
2.Open interest of QFII (DEALER, INVEST) is measured by the ratio of net-buy open interest to the market open interest.

1. Unit root test

When a unit root is not present in a time series, the series is stationary. If the series is not stationary, it is necessary to perform differencing on sequences until no unit root found. The ADF test for stationarity of time series is performed under three conditions: with no constant, with a constant, and with a constant and a time trend term, in a four-variable system. The results reported in Table 2 show that the absolute values of ADF in all three forms are greater than their respective critical values. This implies series of all four variables are stable series without differencing.

Table 2. ADF unit root tests for changes in futures open interests of three major institutional investors and TAIEX returns

Variable	Lag period	Exclude both Constant and time trend items	Include intercept	Include both constant and time trend items
TAIEX returns	1	-16.43804***	-16.42486***	-16.49231***
	2	-14.22952***	-14.21808***	-14.30312***
	3	-12.66622***	-12.65603***	-12.75873***
	4	-11.94405***	-11.93445***	-12.05767***
	5	-11.16932***	-11.16054***	-11.31400***

Open interest of QFII	1	-5.354503***	-5.748389***	-5.949249****
	2	-4.340117***	-4.685648***	-4.832194***
	3	-3.853599***	-4.180514***	-4.298637***
	4	-3.517383***	-3.834243***	-3.930210***
	5	-3.226844***	-3.532950***	-3.610965**
Open interest of DEALER	1	-6.576258***	-6.584044***	-6.669794***
	2	-6.140268***	-6.151965***	-6.254614***
	3	-5.657146***	-5.672347***	-5.791417***
	4	-5.390992***	-5.409658***	-5.544584***
	5	-5.107062***	-5.130850***	-5.288616***
Open interest of INVEST	1	-4.944493***	-6.703012***	-6.783714***
	2	-3.948961***	-5.389518***	-5.468024***
	3	-3.399241***	-4.659676***	-4.738900***
	4	-3.060146***	-4.209191***	-4.290051***
	5	-2.803645***	-3.865795***	-3.948665***

Note: The definition of each variable is the same as the Table 1.

2. Serial Correlation test

The Ljung-Box Q-statistic (LB-Q) test was performed to check if the pre- and post-periods are correlated. Generally, LB-Q for 36 lags indicates the occurrence of serial and nonlinear dependence for every time series. Thus, the 18th and 36th lag periods are selected to determine correlations between the pre- and post-periods. Table 3 shows all four variables to be serial correlated by rejecting the null hypothesis of independence at the respective 5% and 1% significance levels.

Table 3. Results of LB-Q serial correlation test

Variable and lag #		LB-Q statistic	p-value
TAIEX returns	Q(18)	32.217	0.021**
	Q(36)	68.662	0.001***
Open interest of QFII	Q(18)	5051.5	0.000***
	Q(36)	7550.2	0.000***
Open interest of DEALER	Q(18)	2544.2	0.000***
	Q(36)	2993.4	0.000***
Open interest of INVEST	Q(18)	3857.8	0.000***
	Q(36)	6289.2	0.000***

Notes : 1. The definition of each variable is the same as the Table 1.

2. Q (k) denotes Q statistic at the k^{th} period.

3. ** and *** denote rejecting the null hypothesis of independence between the pre- and post-periods at the respective 5 % and 1% significance levels.

3. Optimal lag period

To estimate the VAR model, the appropriate autoregressive order, VAR(p), is required. Following Engle and Yoo (1987), the results in Table 4 show that AIC reaches a minimum for the autoregressive order of 3. Thus, the AR(3) is the proper order to apply in VAR estimation.

Table 4. AIC values for the VAR(p) model

Lag=1	Lag=2	Lag=3	Lag=4	Lag=5
-11.79686	-11.79568	-11.82787*	-11.81954	-11.81954
Lag=6	Lag=7			
-11.79746	-11.76537			

4. Granger causality test

After the appropriate order has been chosen, Granger causality is used to examine whether pair-wise variables have a causal relationship. The causal relationships among all series are summarized in Table 5. It is found that some series are interrelated with each other. Specifically, both DEALER and QFII groups affect TAIEX returns, and TAIEX returns only affects DEALER. That is, the futures trade information of DEALER and QFII is contributory to predicting share returns, and share returns help to predict the behaviour of DEALER.

Table 5. Results of Granger causality test

Causality direction	F statistic	p-value
TAIEX → QFII	1.35791	0.25467
QFII → TAIEX	2.22752	0.08385*
TAIEX → DEALER	3.26807	0.02096**
DEALER → TAIEX	3.34808	0.01881**
TAIEX → INVEST	1.89546	0.12910
INVEST → TAIEX	1.78779	0.14824

Notes: 1. The definition of each variable is the same as the Table 1.

2. * and ** denote one variable is the causality of the other variable at the respective of 10% and 5% significance levels.

Seeing that Granger causality only determines the causal relationship between two variables, it is not suited to testing more complicated cross-dependencies between variables. Thus, the VAR model is employed here to analyze each variable's interaction.

5. The VAR model

Forecast error variance decomposition is an error variance which determines the extent to

which a variable is explained by itself and by other variables. It estimates the relative significance of other endogenous variables, when one variable happens to be self-interrupting. Tables 6–9 present the results of forecast error variance decomposition for each variable in its corresponding period.

Table 6. Forecast error variance decomposition of TAIEX returns at the 100% level

Lag Period	TAIEX	QFII	DEALER	INVEST
1	100	0	0	0
2	98.86695	0.251559	0.033044	0.848448
3	97.55464	0.397345	1.083405	0.964609
4	97.31132	0.602899	1.094013	0.991772
5	97.18087	0.675363	1.093512	1.050257
6	97.06684	0.704674	1.092262	1.136219
7	96.98121	0.738125	1.092082	1.188582
8	96.90363	0.773883	1.091530	1.230955
9	96.83464	0.804148	1.091250	1.269966
10	96.77304	0.833234	1.090907	1.302819
Average	97.54731	0.578123	0.876201	0.998363
Order	1	4	3	2

Note: The definition of each variable is the same as the Table 1.

As shown in Table 6, TAIEX returns for the current period are explained by their own behaviour, and also for 10 lag periods, with an average explanatory power of 97.54%. This implies that its spontaneity is very high, and it is less likely to be affected by other exogenous variables. The second highest explanatory power for TAIEX returns is the INVEST variable, at about 0.99%, which illustrates that INVEST has more influence on the TAIEX returns than other variables. The variable with the least explanatory power is QFII. It should also be noticed that the explanatory rates on the TAIEX returns of each of the QFII, DEALER, and INVEST variables are all quite low (below 1% in each case), and so each influence is undifferentiated.

Table 7. Forecast error variance decomposition for futures open interests of QFII at the 100% level

Lag Period	TAIEX	QFII	DEALER	INVEST
1	0.042859	99.95714	0	0
2	0.211835	99.68053	0.014908	0.092724
3	0.577169	99.09404	0.029537	0.299257
4	0.786183	98.85656	0.037581	0.319671
5	0.857470	98.77560	0.036493	0.330441
6	0.898442	98.69122	0.036541	0.373793
7	0.924283	98.62912	0.035962	0.410630
8	0.939724	98.58623	0.034859	0.439189
9	0.948646	98.54895	0.033794	0.468615
10	0.953352	98.51616	0.032824	0.497667
Average	0.713996	98.93356	0.02925	0.323199
Order	2	1	4	3

Note: The definition of each variable is the same as the Table 1.

Table 7 shows that the forecast error variance of QFII on its current period is explained by the variable itself, as are its 10 lag periods, at a very high rate of 98.93%. This reveals that QFII possesses a high rate of spontaneity, less apt to be affected by exogenous variables. The second highest explanatory power is that of the TAIEX returns, at about 0.71%, which illustrates that the effect of the TAIEX returns on QFII is much more important than that of other variables. The variable with the least amount of explanatory power is DEALER, at about 0.02%.

Table 8. Forecast error variance decomposition for futures open interests of DEALER at the 100% level

Lag Period	TAIEX	QFII	DEALER	INVEST
1	9.679706	16.58283	73.73747	0
2	13.27643	15.01172	71.66732	0.044532
3	15.50880	13.81566	70.59453	0.081010
4	16.11772	13.23503	70.39980	0.247451
5	16.55616	12.70136	70.28001	0.462478

6	16.92427	12.21229	70.17730	0.686147
7	17.21870	11.79960	70.03497	0.946731
8	17.45005	11.44916	69.86846	1.232317
9	17.63457	11.15377	69.68804	1.523616
10	17.77799	10.91082	69.49470	1.816497
Average	15.81444	12.88722	70.59426	0.704078
Order	2	3	1	4

Note: The definition of each variable is the same as the Table 1.

Table 8 indicates that the forecast error variance of DEALER on the current period is explained by the variable itself to about 73.73%, and over its 10 lag periods it is also spontaneous, with a rate of 70.59%. This illustrates the spontaneity of the DEALER variable is very high, and it is not easily influenced by other variables. The second highest explanatory power (at 15.81%) is the TAIEX returns variable, which illustrates that the effect of TAIEX returns on DEALER is more important than that of other variables. The variable with least explanatory power is INVEST, at only about 0.70%.

Table 9. Forecast variance decomposition for futures open interests of INVEST at 100%.

Lag Period	TAIEX	QFII	DEALER	INVEST
1	0.827759	60.70674	2.687942	35.77756
2	2.069867	61.13542	2.726607	34.06810
3	2.932576	61.63909	2.641721	32.78661
4	3.353712	62.09964	2.466361	32.08029
5	3.579926	62.48843	2.341413	31.59023
6	3.751080	62.85325	2.259446	31.13622
7	3.872131	63.16674	2.191215	30.76992
8	3.962187	63.43303	2.133187	30.47160
9	4.032680	63.66692	2.085890	30.21451
10	4.087712	63.87197	2.046777	29.99354
Average	3.246963	62.50612	2.358056	31.88886
Order	3	1	4	2

Note: The definition of each variable is the same as the Table 1.

As shown in Table 9, the forecast error variance of INVEST on the current period is explained by the variable itself to 35.77%, but on its 10 lag periods, the highest explanatory factor is QFII, at about 62.50%. This implies that QFII has a more important effect on INVEST than other variables. The second greatest influence is the INVEST variable, at about 31.88%, with DEALER the lowest at about 2.35%.

V. Conclusions

This article examines the relationship between institutional investors trading in the futures market and the stock market, in the case of Taiwan, based on the Granger causality test and the VAR model. The main data set is the open interest ratios of three major institutional traders and the TAIEX returns from July 2, 2007 to December 31, 2009, a total of 682 daily observations. First, concerning the causality, Granger causality analysis that the QFII group affects TAIEX returns, showing one-way causality, so that the latter does not affect the former. Two-way causality is observed between the DEALER group and the TAIEX returns, showing that each impacts the other. No causality was found between the INVEST group and the TAIEX returns—they have no impact at all on each other.

Of secondary concern was to discover the possible interactive structure between institutional traders and share returns. Here the VAR model shows that the highest explanatory power for TAIEX returns, for open interests of QFII, and for DEALER, in each case is the variable itself. This illustrates that these three variables are highly spontaneous, and are less likely be influenced by exogeneity. The INVEST group has the second highest predictive power for TAIEX returns, which reveals the former is more influential on the latter than are other variables. The lowest explanatory power is possessed by the QFII group. However, it can also be seen that whatever the explanatory power of the QFII, DEALER, and INVEST, their impact on the TAIEX returns is relatively low, in each case below 1%. Therefore, the impact of each group on the stock market indeed holds no comparative significance.

Notes:

1. In case it is based on the daily trading record from July 2, 2007 to June 30, 2010, the empirical result is in line with that of this paper.
2. In case the sample period is divided into two sub-periods—July 2, 2007 to September 30, 2008 and October 1, 2008 to December 31, 2009 — their empirical results produce a consistent conclusion. It seems that the financial crisis in 2008 does not generate a significant effect on the issue discussed in this paper.

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論孫權的戰守策略—以「爭荊州」為例

A Critical Appraisal of Sun Quan's Military Strategy--A Case Study of "Battle for Jing-Zhou"

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摘　要

漢末三國是中國歷史上繼春秋戰國後，又一次分裂亂世的開端，卻也是英雄輩出的年代。孫權以其靈活的政治、外交手段，穩固於江東。

雖說其權掌大局之初已有父兄基業為憑藉而免於顛沛，但他並不以此為滿足，依然禮賢下士、廣納諫言、審時度勢，輔以「吳中對」為基礎的立國策略，終使東吳成為雄據江左的霸主。而對於戰略要地荊州的爭奪，便是孫權執行「吳中對」的最佳實例。聯蜀制蜀策略、抗魏降魏方案的數次改變，終其目的，皆為了取奪荊州，又奪取荊州的原由，便在於以地利的獲得作為東吳永世長存甚至逐鹿天下的資本。這樣的進取策略，孫權不但最終達成，並且依然不違其「聯蜀抗魏」的最高外交指導方針。故對於孫權功業的探索，漢末三國時期荊州的爭奪過程，就成了不可不深知的一頁。

關鍵詞：孫權、東吳、三國、荊州、夷陵之戰

Abstract

The Three Kingdoms Period at the end of Han Dynasty is the second warring and state-splitting period after Warring States Period throughout the Chinese history, and it is a time when heroes rose to power. Sun Quan, with his clever political and diplomatic policies, solidified his reign in the east side of Yantze River.

Despite the fact that Sun's father and brother had laid down the basis of the regime before his reign, saving him a lot of troubles, Sun was not satisfied. He treated intellectuals and talentedwith li, openly accepted opinions and advice, and carefully examined current affairs and warring situations. Following the "Secretive Agreement between Sun and Lu," Sun transformed Eastern Wu into the most powerful regime in the east side of the River. The best example of Sun Quan's implementation of the Secretive Agreement was the battle for Jing-Zhou. Although plans of allying with Shu to control Shu and schemes to fight against Wei had undergone several modifications, Sun's ultimate target was to occupy Jing-Zhou. The reason that Sun attempted the occupation of Jing-Zhou was to win the geographical advantage for the purpose of continuing the authority of Eastern Wu and gaining full control over China. Sun Quan eventually achieved his goal under the framework of his diplomatic policy, "Allying with Shu against Wei." To understand the process of occupying Jing-Zhou is a key to examine Sun Quan's merits.

***Keywords*:** Sun Quan, Eastern Wu, Three Kingdoms Period, Jing-Zhou, Battle of Yiling

壹、前言

整個三國時期的形勢發展，不論是從小說，抑或是從正史來看，皆是孫劉聯合抗曹。赤壁一戰，孫劉聯軍大破曹魏，粉碎了曹操統一天下的美夢，但曹操的兵鋒只是暫時受挫，並非一蹶不振。同樣的，孫、劉雖聯合破曹，兩家之間也非從此相安無事。孫劉聯盟的前提是抗曹，在這一前提之外，東吳與蜀漢集團其實也都各懷有掃平群雄、統一天下的遠大夢想。於是在暫時遏止曹魏鋒芒後，孫權與劉備之間，終不免兵戎相見。

左右孫劉聯盟分合的因素很多，但其中最具關鍵性的是夷陵之戰，而深究夷陵之戰爆發的最根本原因是吳、蜀對荊州的爭奪。考諸正史，荊州在三國時期確爲兵家必爭之地，曹操也曾垂涎荊州，全盛時期甚至逼使荊州刺史劉琮獻城降服，[1]但三國時期荊州的爭奪，主要還是在孫、劉之間，最終並爲東吳所攘括。[2]故個人於此就以吳、蜀分合爲基調，考察孫權在爭荊州過程中所採取的攻防措施，進而探知孫權在群雄逐鹿的東漢末年至三國時期鞏固並壯大東吳的戰守方略。

貳、隆中對與吳中對——爭荊州

如上所言，夷陵之戰是孫劉聯盟分合中，最具關鍵性的戰役。不論是從東吳或蜀漢立場觀之，曾經兩方遵循一貫以來聯盟抗曹的發展策略。在此一大戰略的方針下，共同締造了赤壁之戰的勝利，但在主要敵人暫時不成爲威脅後，緊接而來的便是要面對次要敵人的挑戰。孫劉聯盟是以抗曹爲基礎而成立的，但在抗曹之外，比鄰而居的孫、劉也想在南方獲得較好的戰略位置，爲稱霸天下的大業，在地利上掌握良好的先機，故曹魏暫退到北方後，孫、劉的矛盾便隨之浮上檯面，其矛盾之關鍵即在於荊州的爭奪。

孫、劉兩方對荊州的爭取，早在赤壁之戰甫落幕就已開始，[3]但較激烈的對抗則是從關羽與孫權交惡後，孫權在與曹操取得一定默契下，派呂蒙襲擊荊州，俘殺關羽。有學者批判孫權置孫劉聯盟抗曹的大戰略於不顧，而汲汲於武力奪取荊州是非常不智的舉措[4]，然個人恰恰不以爲然。先從蜀漢而言，劉備三顧茅廬所獲得的「隆中對」中最重要的戰略目標，便是要奪得荊、益兩州，以本文所主述的荊州而言，諸葛亮之所以力主取得荊州，原因在其於不可取代的戰略地位，「荊州北據漢、沔，利盡南海，東連吳會，西通巴蜀，此用武之國……將軍豈有意乎？」[5]而這樣優越的州郡一旦獲得，「跨有荊、益，

[1] 據陳壽著《三國志・魏書》卷十四，〈郭嘉傳〉註引《傅子》記載，曹操欲南向拓疆時，許多人因認爲「南方有疫」而視南向爲畏途，然謀士郭嘉卻認爲曹軍不但要南下，還要先打下荊州。爾後劉琮以荊州獻降，正是曹操南向宏圖的初步實現。

[2] 赤壁之戰雖然曹操大敗，但並未喪失全荊州的控制權，荊州北邊的南陽郡仍在曹操控制下，故孫、劉荊州之爭，實以中、南荊州爲主。

[3] 赤壁戰後，孫權曾表舉劉備爲荊州牧。劉備名義上統領全荊州，然實際上孫、劉各擁荊州一部。建安十五年(210)劉備入京口會孫權，希望能掌控荊州全境，然爲孫權所拒。不久，孫權爲減輕來自北方曹魏的軍事壓力，故在魯肅的建議下，將荊州借予劉備。劉備得益州後，孫權遣人要求劉備歸還荊州，時曹軍入漢中，劉備懼失益州，遂與孫權分荊州爲二治之。

[4] 大陸學者李程在〈孫權外交策略的失敗〉一文中就認爲吳、蜀在荊州歸屬上所產生的矛盾，較之於吳、魏及蜀、魏矛盾來說是次要矛盾，是可以通過和平手段解決，因此孫權助曹襲關是愚蠢至極。李程並引張大可在〈夷陵之戰與三國地理均勢〉一文中「如果孫權不是助曹襲羽而是與蜀共擊曹操的話，則曹魏可能被消滅，那麼孫權再與劉備爭奪天下，就有可能戰勝劉備而一統天下」的看法爲其論據佐證。

[5] 參見《三國志・蜀書》卷三十五，〈諸葛亮傳〉，(台北：鼎文書局，1978)，頁 912-913。

保其巖阻，西和諸戎，南撫夷越，外結好孫權，內修政理；天下有變，則命一上將將荊州之軍向宛、洛……則霸業可成，漢室可興矣。」亦即當三分天下時，據荊州可以自保，而當情勢許可時，荊州便是蜀漢東向進取天下的最佳基地。

再從東吳立場來看，《三國志・魯肅傳》記載孫權於建安五年(200)初見魯肅時的一段對話：

> 權即見肅，與語甚悅之……因密議曰：「今漢室傾危，四方雲擾，孤承父兄餘業，思有桓文之功，君既惠顧，何以佐之？」肅對曰：「昔高帝區區欲尊事義帝而不獲者，以項羽為害也。今之曹操，猶昔項羽，將軍何由得為桓文乎？肅竊料之，漢室不可復興，曹操不可卒除。為將軍計，惟有鼎足江東，以觀天下之釁。規模如此，亦自無嫌。何者？北方誠多務也。因其多務，剿除黃祖，進伐劉表，竟長江所極，據而有之，然後建號帝王以圖天下，此高帝之業也。」[6]

這是孫權初問魯肅平定天下之策時，魯肅的回答。其大意是要孫權立足江東，靜觀天下大勢，侍機而動。其中「竟長江所極，據而有之」就是要完全控制長江沿岸州郡，以作爲爭霸天下的資本。是時長江下游的揚州已在東吳領域內，中、上游的荊、益兩州，便成爲東吳下個階段的攫取目標，建安十三年(208)，劉表病逝，魯肅聞訊後隨即建言孫權：「夫荊楚與國鄰接，水流順北，外帶江漢，內阻山陵，有金城之固，沃野萬里，士民殷富，若據而有之，此帝王之資也。」[7]更是將荊州的重要性提升到益州之上。魯肅在建安五年與建安十三年的兩次談話顯示其圖謀荊州的想法正與諸葛亮不約而同。而後歷史也證明，孫、劉雙方在赤壁戰後對荊州的爭奪，都是在執行雙方謀士對君王的立國策劃。

參、赤壁之戰前後的荊州情勢

前述提及了荊州地理位置的重要性，漢末兩大政治家孔明與魯肅都認爲據有荊州城是開創帝業過程中必須達成的階段性目標。那麼，荊州既然爲漢末三國豪傑所看重，其優越的地理位置已如前述，則它在漢末的情勢發展究竟爲何呢？

東漢以降，中國的政經中心從北方逐漸南移，位居長江中游的荊州，正介於易守難攻的益州與魚米之鄉的揚州間，由於幅員遼闊，漢代將其分爲七郡，輔以物產豐富，在南移之初遂成爲取代北方州郡的富饒之地。

荊州位置之重要，不只孫、劉兩集團時刻摩拳擦掌，意欲奪取，同具戰略思想的曹操亦早已虎視眈眈。官渡之戰結束後，曹操基本上已統一北方，隨即將眼光向南掃視，最先目標即是「西擊劉表」，拿下荊州。迨誅除北方袁紹殘餘勢力後，建安十三年七月，曹操完成所有準備，遂開啓大軍南進之路。

荊州既有占有得天獨厚的地理位置，東漢末年討伐董卓的各路諸侯，無一不想拿下荊州雄據一方，然在劉表入主荊州後，諸侯染指荊州的野心暫得壓抑。可惜的是，劉表治理荊州雖然政績卓著，[8]只劉氏一門畢竟非亂世豪傑，曹軍出征後不久，繼任劉表掌荊

[6] 參見《三國志・吳書》卷五十四，〈魯肅傳〉，(台北：鼎文書局，1978)，頁 1268。
[7] 參見《三國志・吳書》卷五十四，〈魯肅傳〉，頁 1269。
[8] 據范曄著《後漢書》卷七十四，列傳六十四(下)，〈劉表傳〉記載，劉表治理荊州「初，荊州人情好擾，加四方震駭，寇賊相扇，處處襲沸。表招誘有方，威懷兼洽，其奸猾宿賊更爲效用，萬里肅清，大小咸悅而服之。關西、兗、豫學士歸者蓋有千數，表安慰賑贍，皆得資全。遂起立學校，博求儒術……愛民養士，從容自保。」

州的劉琮竟開城出降曹軍。曹操拿下荊州後，原本依附於劉表的劉備一路敗退，最終落腳於當陽。同一時間，在江東的孫權得知曹操拿下荊州後，確信曹氏集團下一步將是降服東吳，爲求自保，乃命魯肅以弔劉表之喪爲名，過江與劉備商議聯盟抗曹。

孫、劉結盟後，曹軍南下，建安十三年，影響中國歷史走向的赤壁之戰爆發，曹操大敗，退回北方，原本赤壁戰前擁據荊州全境的勢力，至此僅剩荊州北部南陽一地，而劉備乘勝占領南荊州桂陽、零陵、長沙、武陵四郡，孫權則得南郡與江夏兩地。故其後孫、劉荊州之爭遂以中南方荊州爲主。

肆、孫權奪荊州的經過

孫權接掌江東父兄政權之初，一席「吳中對」讓他初次體會到，在爭奪天下的過程中，長江沿岸諸郡的控制對孫氏政權立足一方的重要性。赤壁之戰爆發前夕，不但謀臣魯肅進一步向孫權提醒擁據荊州對於東吳的益處，就連武將甘寧，也向孫權獻策「南荊之地」的獲得與東吳遠規巴蜀間的利害關係。[9]孫權聞言後皆「深納之」，可見東吳君臣對圖取荊州以作爲逐鹿天下的資本，顯然已構築起基本的共識。

赤壁之戰方結束，劉備趁周瑜與曹仁在江陵激戰之際，以迅雷不及掩耳的速度拿下荊南四郡，孫權無奈之餘，遂派赤壁之戰首席功臣周瑜進駐未落劉備勢力的南郡與江夏郡，中、南荊州遂形成孫、劉分治的局面。然周瑜駐守江陵不到一年便英年早逝，於是執行孫權荊州政策與折衝孫、劉關係的要任，遂實際由繼任的魯肅與呂蒙手中延續，併最終得到徹底解決，故下一小節將以魯肅與呂蒙輔佐孫權時期的荊州政策爲主，探討孫權對荊州政策的取捨轉變。

一、魯肅輔政時期的荊州政策

周瑜死後，魯肅繼任，一反周瑜生前欲滅劉備集團的意志，對於劉備採取友善的態度，對於孫、劉之間存在的問題，也盡量採取和平解決的方式，這樣的外交策略正與孔明「結好孫權」的方針不謀而合，於是開展了繼赤壁同盟敗曹後，孫、劉第二階段的磨合期，而雙方磨合與否的關鍵就在「荊州問題」。

由於曹操敗回北方後，轉而集中心力經營關隴，孫、劉間在暫時解除北方威脅後，棘手的荊州歸屬問題立刻浮上檯面。劉備拿下荊南四郡後，於建安十五年(210)「詣京見孫權，求都督荊州」[10]，但無功而返。魯肅輔政後，鑒於北方曹操依然東吳最大的威脅，故惟有拉攏劉備同盟，才是東吳政權存續的最佳保障，於是在荊州問題上，對劉備做了兩次讓步。

第一次發生於建安十五年，劉備赴京口與孫權商議借荊州事，當時孫權麾下皆反對，周瑜甚至還主張將劉備扣留在東吳，惟魯肅卻獨排眾議，力主將荊州借給劉備。[11]魯

[9] 據《三國志・吳書》卷五十五，〈甘寧傳〉記載，建安十三年初，原隸屬於黃祖麾下的甘寧投奔孫權，向孫權獻策曰：「今漢祚日微，曹操彌憍，終爲篡盜。南荊之地，山陵形便，江川流通，誠是國之西勢也。寧已觀劉表，慮既不遠。兒子又劣，非能承業傳基者也。至尊當早規之，不可後操。圖之之計，宜先取黃祖。祖今年老，昏耄已甚，財穀並乏，左右欺弄，務於貨利，侵求吏士，吏士心怨。舟船戰具，頓廢不修，怠於耕農，軍無法伍。至尊今往，其破可必。一破祖軍，鼓行而西，西據楚關，大勢彌廣，即可漸規巴蜀。」

[10] 參見《三國志・吳書》卷五十四，〈魯肅傳〉，頁 1270。

[11] 據《三國志・吳書》卷五十四，〈魯肅傳〉註引《漢晉春秋》記載，對於劉備求都督荊州一事，魯肅站在抗曹的立場認爲孫權「初臨荊州，恩信未洽，宜以借備，使撫安之。多操之敵，而自爲樹黨，計之上也。」

肅的考量無非是希望藉由劉備的壯大以增加曹操的敵人，其出發點明顯在於考慮到曹魏勢大，以東吳一方抗曹，恐力有未逮，故培植與曹操勢不兩立的劉備集團力量，可有效分散東吳的抗曹壓力。孫權雖初不採魯肅的建議，但爲時不久，即轉變態度，從其意見。

魯肅對孫權的第二次讓步則是在劉備拿下益州之後。

建安十九年(215)，劉備以荊州爲根據地，出兵奪取益州，初步完成諸葛亮隆中對「兼跨荊、益」的戰略目標。孫權看到劉備已拿下益州，乃遣人入蜀，求還所借荊州(指南郡)，遭到劉備託辭拒絕。孫權大怒，遂在隔年遣呂蒙與魯肅將兵，準備以武力奪取劉備在中、南荊州的所有地盤。劉備得知訊息後，也加強荊州攻防部署，就在雙方劍拔弩張之際，位居前線的魯肅，不顧眾人基於安全立場的反對，與關羽進行了一場「單刀會」。在這次會面中，魯肅對於劉備不交還所借荊州的舉動，向來對劉備和善的態度也不得不轉而義正辭嚴。爾後劉備考慮到初得益州，人心未定，若擅與吳興兵，恐曹操乘機躡其後，於是主動「使使求和於權」，孫權方面「令諸葛瑾報命，更尋盟好」雙方遂以湘水爲界，平分荊州。

此次危機的解除，乍看爲劉備所主動，但《三國志・魯肅傳》中有這麼一段記載「後備西圖璋，留關羽守。權曰：『猾虜乃敢挾詐!』及羽與肅鄰界，數生狐疑，疆埸紛錯，肅常以歡好撫之。」[12]顯見早在劉備未入益州前，鎮守江陵的關羽與守陸口的魯肅就已成對峙之勢，關羽爲人心高氣傲，魯肅卻主動「以歡好撫之」。對於魯肅這樣的態度，有部分學者認爲，魯肅和緩態度的背後依然是欲「圖取關羽」。但個人以爲，魯肅在建安初年與赤壁之戰前夕，兩次對孫權提到荊州的重要性，尤其是第二次，直接挑明要君臨天下，一定要拿下荊州。以東吳實力高於蜀漢，加上魯肅最初向孫權所言圖取霸業的主張，身爲吳國首席大臣兼前線主帥，實可不必甘冒放棄最初意志的可能而主動向蜀漢示好，即便是顧慮到曹魏有鷸蚌相爭，漁翁得利的可能，魯肅也只要做好駐守工作，免於挑動吳、蜀戰端即可，不必與敵人有任何交流。故對於魯肅的軟性態度，個人認爲應是他一貫堅持孫、劉和平共存的主張，從而多以和善的態度，主動面對亦友亦敵的蜀漢。

魯肅如此作爲，對於化解孫、劉荊州前線的緊張情勢，一定有起作用。但最重要的是，以和爲貴的態度，從孫吳朝廷到前線皆始終如一，他輔政七年，兩次與劉備在荊州問題上的交手，並不算多，但七年間，孫、劉卻能和平共處，最主要原因當然是兩方皆有最大敵人是曹操的共識，而孔明結好東吳方針與魯肅的和平策略，正是不約而同。兩方策略的高度一致性，可以想見必然對於孫、劉和平共處的發展有著催化作用。

二、呂蒙輔政時期的荊州政策

建安二十二年(217)魯肅去世，呂蒙接任。孫、劉間荊州問題也隨著輔政者的異動而進入一個新的階段。

前述曾提及，魯肅輔政時期，對孫、劉關係採取的是和平外交，而對於鎮守江陵的關羽，魯肅亦勸孫權「曹公尚存，禍難始搆，宜相輔協，與之同仇，不可失也」[13]即便孫權一直想拿回荊州，但以和爲貴的政策，依然成爲魯肅輔政時期，孫吳對劉備集團奉行最高的指導原則。然呂蒙繼任後，以爲「羽驍雄，有并兼心，且居國上流，其勢難久」，遂密陳孫權：

> 且羽君臣，矜其詐力，所在反覆，不可以腹心待也。今羽所以未便東向者，以至尊聖明，蒙等尚存也。今不於彊壯時圖之，一旦僵仆，欲復陳力，其可

[12] 參見《三國志・吳書》卷五十四，〈呂蒙傳〉，頁 1272。
[13] 參見《三國志・吳書》卷五十四，〈呂蒙傳〉，頁 1278。

得邪？[14]

顯見呂蒙一上台，就已確定武力解決荊州問題的方向，而孫權在遭到關羽的羞辱後，也認爲收併荊州一事，不可無限期拖延下去，因此毫不保留的完全採納呂蒙意見。

就在孫權決定以武力解決荊州問題時，關羽爲策應劉備攻打漢中的戰爭，發動襄樊戰役，關羽部隊一路勢如破竹，逼得曹操欲遷都避禍，但司馬懿與蔣濟勸曹操聯絡孫權，以「割江南」的條件，使孫權背後襲羽。孫權得知消息後，欣喜於奪取荊州的舉動竟有意外之助，遂同意與曹操聯合。而直接奪取荊州的軍事任務便落到呂蒙手上。

呂蒙一到陸口，便對關羽噓寒問暖，降低了關羽對呂蒙的敵意，隨後他爲徹底解除關羽對東吳的防範，乾脆假裝稱病辭任，以當時尚名不見經傳的陸遜代替職位。陸遜到任後，一方面延續呂蒙的計策，持續麻痺關羽，一方面則與呂蒙密議偷襲江陵的計畫。中計的關羽果然不知呂蒙真正用意，錯誤的判斷東吳無取荊州之心，遂調駐守江陵的重兵前往樊口助戰，而呂蒙這方面，先是成功麻痺關羽，繼之對江陵蜀軍的一舉一動透過情報工作徹底掌握，隨後則「使白衣搖櫓，作商賈人服，晝夜兼行，至羽所置江邊屯候，盡收縛之」[15]，成功收服了江陵守軍。進入江陵後則採取懷柔政策，使得蜀軍不論是江陵城內，或者是隨關羽敗走的部隊，皆人心思變。最後截斷關羽的退路，擒俘關羽，底定荊州，荊州遂爲東吳所有。自此至東吳滅亡，荊州未再易手。

三、孫權荊州政策的轉變探討

從反對借荊州、同意借荊州、平分荊州領導權，再到以武力奪回中南荊州全境控制權。孫權對於荊州的態度大致上是從強硬、和緩、再回歸強硬的三度轉變。其間的心路歷程從現存史載上分析，與輔佐者的策略和當時局勢演變有莫大的關係。

孫權知人善任，歷來評述者皆以爲美，他曾說過：「思平世難，救濟黎庶，上答神祇，下慰民望。是以眷眷，勤求俊傑，將與戮力，共定海內」[16]，還說過：「天下無粹白之狐，而有粹白之裘，眾之所積也。夫能以駁致純，不惟積乎？故能用眾力，則無敵於天下矣；能用眾智，則無畏於聖人矣。」[17]，且他與部屬間雖爲君臣之名，卻以義氣相交，他在鼓勵大臣勇於進諫的詔書中就說過：

> 今日諸君與孤從事，雖君臣義存，猶謂骨肉不復是過。榮福喜戚，相與共之。忠不匿情，智無遺計，事統是非，諸君豈得從容而已哉！同船濟水，將誰與易？[18]

對於人才的充分運用、推心置腹、用人不疑，孫權不但說到，而且做到，因此進入吳地的人才皆樂爲所用。當然，孫權的用人絕不是毫無選擇性，周瑜在其兄孫策掌權時期，就跟隨孫家東征西討，戰功彪炳，還與孫策結爲莫逆，孫權繼位後引爲股肱理所當然。魯肅以「吳中對」爲進身之階，前述已提過，此處不再贅述。呂蒙與陸遜皆是從年輕時即入孫吳麾下，經過不斷的磨練，爲孫權所賞識，進而爲其重用。因此長年下來，不管是兄長遺下的顧命大臣，抑或孫權所識拔，其才幹與忠誠皆已在亂世浮沉中獲得肯定，故對於臣下的主張，在思慮過後覺得可行時，便放手讓臣子去做，輔以孫權心中有

[14] 同註 13。
[15] 同註 13。
[16] 參見《三國志・吳書》卷四十七，〈吳主傳〉，頁 1137。
[17] 參見《三國志・吳書》卷四十七，〈吳主傳〉註引《江表傳》，頁 1143。
[18] 參見《三國志・吳書》卷四十七，〈吳主傳〉，頁 1143。

明確的大戰略原則作指導，故同一政策雖可能數變，卻不致失序。

知人善任固然是君王擇才、用才的最高準則，但一位君王若只擅於任用人才而不明所處時勢，則恐反爲有心之人所利用。善於審時度勢便是孫權的另一項特質。以荊州問題來說，赤壁之戰後，劉備趁孫、曹江陵激戰時，遣軍拿下荊南四郡，勢力快速膨脹，孫權明知吃暗虧，卻不急於奪回，反而「進妹固好」，但當劉備欲都督全荊州時，孫權卻又堅定的予以回絕，可見他在初面對荊州問題上，張弛之間便已得宜拿捏。時周瑜信心滿滿欲滅劉備，孫權同意了，但周瑜早死，計畫遂來不及實行。魯肅繼任後則一反周瑜面對蜀漢時的武力針對策略，對力主與占有荊州一部的劉備採取和平共存的方針，甚至不惜借荊州給劉備。孫權對兩種截然不同的意見都採納了。孫權不可能沒有意識到，魯肅的孫劉聯盟策略違反了當初兩次建言都認爲江東孫氏欲成帝業，必然要拿下包括荊州在內的長江控制權的主張，但他顯然更清楚東吳的主要敵人是曹魏，與勢力相近的劉備火拼，恐會造成兩敗俱傷的後果，他會同意周瑜滅蜀計畫，在於他對所用之部屬的信任，而他相信魯肅的聯盟抗曹計畫，除了對部屬的信任外，恐怕更多是對現實的認清，如此審時度勢的外交謀劃，讓孫權對荊州問題可以靈活運動，終於在北方敵人暫不成威脅，甚至願成爲孫吳奪取荊州之戰的犄角後，孫權遂一改平和面對荊州問題的態度，轉而同意呂蒙以武力解決的主張。

由上述可知，孫權對荊州政策最高指導原則的轉變，立基點在於對部屬的完全信任，因此從周瑜的滅蜀，到魯肅的聯蜀，再到呂蒙的圖荊州，他都毫不猶疑的依照輔政大臣的不同主張，而對東吳戰略規劃改弦更張，他懂得觀察時變，亦使得他對於荊州問題處理方式雖不斷轉彎，卻不會產生患得患失、不知所措的情況，最終得以拿下大部分荊州地域的控制權。

伍、夷陵之戰

一、戰役緣起

夷陵之戰可說是孫、劉爭荊州的最終對決，此戰爆發的原因，歷史記載歸因於劉備欲報孫權襲殺關羽之仇，但這裡要從兩處觀察：其一，劉備若能在夷陵打敗孫權，則不但能報兄弟被殺之仇，還能順勢奪回荊州，不但可保「隆中對」戰略的順利執行，甚至還有可能消滅孫吳，一舉數得。其二，當時的蜀漢文武大臣大都清楚，蜀漢根本沒有與東吳翻臉的本錢，與東吳爲敵，簡直是在削弱自己的國力，著實不智[19]。前者是理想面，但理想中帶有很大比例的投機成分，後者態度上雖較消極，但卻是從現實面考量。不過從第一點觀察，就可以明白劉備爲何不聽勸阻，對於伐吳之事一意孤行。而綜合兩者觀之，或可解答正史上孔明對於劉備欲伐吳，態度曖昧不明的原因。

劉備發動夷陵之戰的原因與蜀漢臣子對此戰的態度已如前述，而陷於攻防被動的孫權，面對排山倒海而來的蜀漢雄兵，先是戰前遣使求和，卻毫無轉圜的餘地，於是一方面是劉備怒髮衝冠的興師而來，一方面則是東吳緊張的做防禦準備[20]。不愧是一國之主的孫權，在初獲訊息的驚慌之後，很快的恢復了冷靜，以軍事和外交雙管齊下的策略，

[19] 根據《三國志・蜀書》卷三十七，〈法正傳〉記載，劉備爲報孫權襲殺關羽之仇，決定征吳，但「群臣多諫」。另卷三十六，〈趙雲傳〉亦有趙雲諫阻劉備伐吳的記載，但「先主不聽」，終至兵敗夷陵。

[20] 根據《三國志》記載，孫權得知劉備欲伐吳，曾遣諸葛瑾入蜀求和，但劉備「盛怒不許」。孫權遂拜陸遜爲大都督備戰。

面對赤壁戰後，東吳最大的危局，並最終得以順利解決。以下分述之：

二、夷陵之戰與東吳外交

(一)夷陵戰前——聯魏制蜀

蜀漢章武元年(221)，劉備東征孫吳，初戰就獲勝，東吳邊境蠻夷望風響應[21]。孫權面對可能動搖國力的戰鬥，除了加緊軍事防禦外，外交上，則延續荊州之戰時的策略，爲避免腹背受敵，乃採聯魏制蜀的方針，對於曹魏主動降格稱臣[22]。

曹魏向來是孫吳欲統一天下的最大障礙，孫權之所以屈辭於曹魏數年，就現今史料考察，雖在合肥戰役後，孫權曾有「令都尉徐詳詣曹公請降」的舉動，但若事件牽涉與蜀漢的關係，則聯魏並非孫權外交捭闔上的第一選擇。只因關羽鎮守荊州時，孫權欲與關羽結兒女親家被拒，荊州之戰後，遣使入蜀議和又被拒。蜀漢兩次明顯違反同盟抗曹的舉動，方逼得孫權爲減低兩面受敵的可能性，不得不對曹操稱臣。尤其劉備伐吳的目的，不只是報仇而已，已含有奪回荊州，甚至一舉滅吳的打算，故舉國而來的兵力讓孫權意識到，此戰成敗恐影響孫吳存亡，因此除了軍事上的調動，外交上，他最初依然抱持著與蜀和平共存的想望，但在戰前對蜀議和失敗後，對最大敵人曹魏的稱臣，便有著防範劉、曹聯合，間接制蜀的作用，故暫時性降曹成了孫權當下唯一可走的路。

(二)夷陵之戰——破蜀禦魏

在夷陵之戰爆發初期，蜀軍勢如破竹之際，孫權大膽重用了青年書生陸遜領兵。陸遜也不負眾望，以其堅忍與才智，靜待時機，最終「營燒七百里」打敗了劉備。但不同於劉備從報私仇、奪荊州而進欲滅吳，陸遜並未被吳軍的大勝沖昏頭。此時東吳軍隊一反夷陵之戰初期一路挨打的局面，卻是火燒連營，士氣正盛。擺在陸遜面前有兩條路可選擇，一是趁兵鋒正銳，長驅西川，一舉滅蜀；一是見好就收，班師保吳。前者是由防禦固守轉爲全面進攻，後者則是謹遵以守爲攻的作戰策略。陸遜明確選擇了後者，其原因在於他料中了曹丕有趁吳、蜀相爭之際，襲吳後方，以取得「鷸蚌相爭，漁翁得利」的勝利。但他難道沒想過，吳若能一舉滅蜀，吳軍士氣必然更盛，則魏雖襲吳後方，吳仍可以蜀地爲立基，回師與魏一爭長短或者直接在易守難攻的蜀地重植吳軍大旗。歷史沒有說明陸遜是否有想到這個選項，然在夷陵戰役結束之初，正史中有這麼一段記載：

> 又備既住白帝，徐盛、潘璋、宋謙等各競表言備必可禽，乞復攻之。權以問遜，遜與朱然、駱統以為曹丕大合士眾。外托助國討備，內實有姦心，謹決計輒還。無幾，魏軍果出，三方受敵也。[23]

由這此段記載可知，陸遜之所以回師保吳，主要在於獲知曹丕在江北已經整兵秣馬，虎視眈眈。又裴松之引《吳錄》中有這麼一段話：

> 劉備聞魏軍大出，書與遜云：「賊今已在江陵，吾將復東，將軍謂其能然不？」

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[21] 根據《三國志・蜀書》卷三十二，〈先主傳〉記載，劉備伐吳，軍次秭歸時，武陵五谿蠻夷已「遣始請兵」，劉備於猇亭駐營時，又遣馬良安慰五谿蠻夷，蠻夷「咸相率響應」。另《三國志・吳書》卷四十七，〈吳主傳〉亦載，劉備伐吳，至巫山、秭歸，「使使誘導武陵蠻夷，假與印傳，許之封賞，於是諸縣及五谿民皆反爲蜀。」

[22] 根據《三國志・吳書》卷四十七，〈吳主傳〉記載，孫權從建安二十二年(217)即已屈身事曹，夷陵之戰時的對魏稱臣，乃是延續其聯魏以制蜀的政策。

[23] 參見《三國志・吳書》卷五十八，〈陸遜傳〉，頁 1348。

遜答曰：「但恐軍新破，創痍未復，始求通親，且當自補，未暇窮兵耳。若不惟算，欲復以傾覆之餘，遠送以來者，無所逃命。」[24]

蜀漢雖在夷陵之戰大敗，但依劉備給陸遜的信來看，蜀軍似乎仍有一夕間捲土重來的實力。然陸遜的回覆雖顯示其面對蜀漢可能再挑釁，胸有成竹，但蜀軍雖敗於夷陵，吳軍在此戰卻亦耗損不少，若真深入西川，要面對的恐仍是場場硬仗，征蜀之役，絕非短期可結束，而精銳盡出於夷陵的東吳，面對實力高過自己許多的曹魏挑釁，是絕無抵禦之力。故綜合《三國志》與《吳錄》可推知，陸遜不被一時的勝利沖昏頭，當下作了班師回吳的關鍵性決定，將東吳精兵用於守勢作戰，一方面以其勝利之餘威採防禦固守，可對欲入侵者產生相當程度的威嚇作用，另一方面也避免長期用兵可能對國力產生的大規模消耗。

陸遜領導吳軍於夷陵大勝後的攻防策略構成之始末，已如前述。但陸遜畢竟是爲人臣下，在戰術層面，他也許可以專斷，但在更高的戰略層面，他雖可以有意見，然最終的決定權還是在他的主子孫權身上，故東吳的戰守策略之最終取決還是要看孫權的態度。

建安十八年(213)曹操攻濡須，與孫權相拒於濡須口，《三國志》記載「曹公望權軍，歎其齊肅，乃退」，裴松之則引《吳歷》補充「公見舟船器仗軍伍整肅，喟然歎曰：『生子當如孫仲謀，劉景升兒子若豚犬耳！』」

曹操頗具識人之明，麾下眾多的謀士武將，很多都是由曹操所拔擢或原先未投曹營之前，即爲曹操所賞識，故其對孫權的評語也絕非無的放矢。而事實也證明，孫權確實有在逆境中扭轉乾坤，甚至化阻力爲助力的能耐。

(三)夷陵戰後—聯蜀抗魏

蜀漢戰敗後，荊州終歸東吳掌握，雖然孫權因其它問題依舊向曹魏表面請和，但曹丕鑒於孫權對魏態度反覆不定，故要求先前雙方議定孫吳送人質入曹魏一事須馬上執行，孫權在無可選擇的狀況下，遂對曹魏訴諸武力，同時未免戰敗的蜀漢與曹魏聯合，乃遣使入蜀漢請和，亦獲蜀漢友善回應，於是吳蜀再度聯盟，曹魏獲知後遣兵攻吳，卻無功而返，東吳反擊亦遭失敗。經過一連串和戰反覆，孫權深知東吳雖無力滅曹魏，然限江自保猶有餘力，只欲抗魏，猶應聯合蜀漢，輔以派使入魏，卻遭魏扣留，適巧蜀漢派使議和，孫權幾經考慮後，乃絕魏聯蜀。

夷陵戰後七年，孫權在武昌即皇帝位，年號黃龍，孫權這一稱帝的舉動，等同與曹魏撕破臉。蜀漢方面雖然亦有不滿聲浪，但在諸葛亮衡量當時局勢後，最終承認孫權帝號，並「遣衛尉陳震慶權踐位」孫權稱帝得蜀漢正式承認後，更加底定其聯蜀抗曹的策略，甚至預與蜀「交分天下」，此一外交準則，終孫權之世再無異動。

三、小結

吳、蜀夷陵戰前，孫權積極求和，顯見孫權一開始已無意打這場戰爭。但要注意的是，孫權不想與蜀漢全面衝突的根本原因，並非實力不足，而在於他已經據有荊州，在與蜀漢的競逐之中，於地利上已立於不敗之境。

從「吳中對」與「隆中對」的內容中可以發現，吳、蜀爭奪天下的步驟中，據荊州

[24] 參見《三國志・吳書》卷五十八，〈陸遜傳〉註引《吳錄》，頁 1348。

是共同的立基點。又魯肅積極拉攏劉備共同抗曹，與孔明「隆中對」聯吳抗曹的態度正不謀而合，足見吳、蜀在戰略設想上有著極高的相似度。而這樣的戰略構想，在東吳拿下荊州後，已先於蜀漢完成國家戰略位置的規劃，故孫權當然無意打一場非在其戰略規劃內的戰爭。因此在夷陵戰後，東吳雖大勝，卻反而先遣使求和。這可從《三國志・蜀書・先主傳》中有這麼一段記載「孫權聞先主住白帝，甚懼，遣使請和」證明。只是比較令人疑惑的是，從上述記載來看，孫權似乎是因懼怕劉備而請和，但事實告訴我們，諸葛亮在確定失去荊州，「隆中對」戰略指導幾乎成爲泡影的現實下，還願意與東吳講和，顯見除了夷陵戰前，多位蜀漢重臣已反對打這場戰爭外，諸葛亮也深知蜀漢在防禦曹魏這個主要敵人外，國力已不足再與次要敵人較量，由此也間接可知劉備在夷陵之戰後，還致書陸遜欲捲土重來，顯然是一句大話。然孫權畢竟非蜀中人士，是否了解蜀漢國力的真相，不得而知，但東吳可以從蜀漢勇將關羽手中拿回荊州，再破劉備於夷陵，則陳壽記載孫權在夷陵戰後因「甚懼」而請和說法，似乎太過勉強。

由戰爭爆發前的積極求和，到戰勝後的主動請和，及否定諸將趁勝追擊滅蜀的舉動，同意陸遜回防東吳的構想，可知孫權對夷陵之戰自始至終都定位在防禦作戰，顯見孫權除因勢奪荊州，而必須暫與蜀漢爲敵外，即便其後來稱帝，竟能拋開天無二日的觀念，對於蜀漢帝號採取並尊承認的方略，則孫權與蜀漢的關係雖然幾經轉折，東吳群臣對蜀漢的和戰政策也始終存在著分歧，但孫權在權衡眾議之餘，其內心「聯劉抗曹」的大戰略導向是非常明顯且堅定的。

陸、東吳戰守策略分析

荊州之戰與夷陵之戰可以說是決定漢末三國荊州歸屬的兩場決定性戰役，東吳在這兩場戰役都大獲全勝，但面對這兩場戰役的態度則有顯著不同。東吳在荊州之戰是採取主動攻擊的策略，而夷陵之戰則是採取被動防禦。其中，在荊州之戰爆發前，孫權麾下的重臣魯肅曾向關羽索討荊州。夷陵戰前，孫權遣人求和於劉備，卻絕口不提歸還荊州之事，由此個人已可略窺孫劉聯盟這一大架構下，在孫權這方面的設想前提。故從吳、蜀荊州之爭的始末分析，孫權的戰守策略大概可歸類爲三：

一、戰略位置的掌握

荊州在三國時期軍政地位之重要，已於上開章節論述過，尤其對於雄踞江南的孫、劉兩家，荊州的得失更是決定誰能在江左掌握戰略主動，因此對荊州的圖取，孫、劉皆當仁不讓。

赤壁之戰，孫劉聯軍雖大敗曹魏，但曹操的力量損害有限，對孫、劉仍構成相當的威脅。在如此情況下，孫權竟還敢主動發起對蜀漢的荊州之戰。他不可能沒顧慮到孫、劉交兵即有可能讓魏國得利。更何況孫權所面對的除了是可能破壞孫劉聯盟的嚴重後果外，最直接的即要與蜀漢第一戰將且甫「水淹七軍」氣勢正盛的關羽交鋒，足見孫權這場賭注的冒險性是非常大的，但他卻毅然行動，其原因在於襄樊之戰一旦由蜀漢獲勝，曹魏即可能覆亡，則蜀漢將以兩面包夾之勢與東吳對峙，尤其荊州一失，將使東吳引以爲自保的長江天險面臨嚴重威脅，反之若能從關羽手中拿下荊州，將可先蜀漢一步完成戰略規劃，達成牽制蜀漢的效果，並在孫劉聯盟的棄留上握有主動權，因此兩相對照，

得失之於孫權眼前已非常明顯，故孫權不惜一度違背吳蜀聯盟，而暗聯曹魏偷襲關羽。由此可推知孫權心中所謂的孫劉聯盟，其前提是東吳必須要佔有較之蜀漢爲優勢的地位——亦即囊括在圖霸中原前，將一切最有利的因素，成功的置於己身。故孫權明知在三強鼎立的時代，必須與蜀漢聯盟方能自保，卻仍大膽的執行部分以武力逼迫劉備退卻的策略，達成佔有江左軍事要衝的目的，東吳此一舉措很明顯是在戰略上將地利因子(奪荊州)提升與人和因子(孫劉聯盟)並重，甚至偶有超越般看待。反觀蜀漢，雖於赤壁一役後，立即於荊州之爭奪，但絕對性的敵我分判，使其在以外交政策輔助版圖的擴張上，限縮了迴旋的空間。其後對東吳交通策略的頻頻失誤，使得原先在地利上權握的先機，快速的失去，甚至最終淪於人和與地利無法兼顧的窘境。由此考察，孫權所採行的相對性敵我區隔的全方位外交策略以遂鼎立之勢的續行及戰略位置的最終掌握，其思考上顯然更爲全面。

二、外交捭闔的靈活運用

就正史觀之，荊州之戰與夷陵之戰，蜀、吳的兩次交鋒，在戰前，蜀漢從未對曹魏實行外交上的任何緩兵計策，且關羽守四戰之地荊州，前有曹魏強大的威脅，竟然還對孫權的求親出言不遜，客觀上已將自己置於四面樹敵的危境。反觀東吳，荊州之戰是與昔日死敵曹魏達成某種互利的默契下行之，[25]夷陵之戰前，孫權更不惜對曹魏稱臣，以換得北方敵人的按兵不動，故可以避免兩線作戰的危險。蜀、吳接皆無承受兩面同時作戰的實力，但相較之下，孫權的戰守策略融外交與軍事於一爐，進行敵友之間角色的靈活互換，不但屢屢避免陷自己於兩面作戰的危險，還成功達成「吳中對」中的戰略目標，顯然較一方面堅持漢賊不兩立而與曹魏形同水火，一方面死守孫劉聯盟，卻又數度與盟友翻臉的蜀漢層次爲高。

三、大戰略方針的堅持

東吳與蜀漢之間，雖然曾爲了荊州而打了兩次大戰，但整體而言，東吳面對三分天下的大戰略還是聯蜀抗曹。赤壁之戰如此、荊州之戰前也是如此，夷陵之戰前後的態度也沒變。[26]孫權之所以不論與蜀、魏任何一集團爲敵爲友，他的大戰略方針始終未變，這是因爲孫權很清楚，東吳與曹魏國力相距甚大，與曹魏爲友無疑是與虎謀皮，故只能作爲在某些不得已狀況下的權宜之計。與蜀漢爲友雖亦非長久之計，但兩國實力相近，比之於曹魏，蜀漢顯然較不具威脅性，且兩方在對外戰略目標上的相似性較大，可磨合處較多。因此，赤壁之戰，東吳的聯蜀策略，一挫曹魏兵鋒，暫解亡國之危。吳、蜀荊州之爭初期，孫權採行和親策略甚且表舉劉備爲荊州牧，以在北方強大的威脅下，對蜀漢展現最大的聯盟誠意。即便荊州、夷陵戰後，孫權雖取得南方最佳戰略位置，但他依

[25] 據房玄齡著《晉書》卷一〈帝紀第一・高祖宣帝〉記載，關羽水淹七軍後，曹操欲遷都河北，司馬懿反對：「禁等爲水所沒，非戰守之所失，於國家大計未有所損，而便遷都，既示敵以弱，又淮沔之人大不安矣。孫權、劉備，外親內疏，羽之得意，權所不願也。可喻權所，令掎其後，則樊圍自解。」魏武從之。權果遣將呂蒙西襲公安，拔之，羽遂爲蒙所獲。

[26] 據《三國志・蜀書》卷四十五，〈鄧芝傳〉記載，夷陵戰後，孔明遣鄧芝前往東吳議和，孫權告訴鄧芝：「孤誠願與蜀和親，然恐蜀主幼弱，國小勢偪，爲魏所乘，不自保全，以此猶豫耳。」

然回頭執行聯蜀外交，因爲聯蜀罷戰不但使全國軍民得以休養生息、併得與蜀漢化解先前相互仇視之芥蒂，且還能相互照應，免爲曹魏所各個擊破，一舉數得。所以孫權在位時期，即便與魏、蜀有戰有和，但聯蜀抗魏的大方針從未改變。

柒、孫權坐擁東南之思維探究

上開章節論述中，曾約略提及孫權能攘括荊州大部以坐斷東南江山，與其善於識人用人、審時度勢，以貫徹國家大戰略的執行有很大的關係。觀諸三國時期有爲的領袖，率皆重視人才的引進與運用，曹操重才不重德的「求才三令」、劉備除武備方面得關張趙諸良將協助，文事得孔明輔佐更說出：「孤之有孔明，猶魚之有水。」而與曹、劉鼎足的孫權亦不例外，孫策臨死前，將印綬付權，即說過：「舉江東之眾，決機於兩陳之間，與天下爭衡，卿不如我；舉賢任能，各盡其心，以保江東，我不如卿」[27]孫權繼位後的知人善任，也證明了孫策的眼光。

然孫權的用人哲學，並非毫無主見的聽任臣下自便，而是灌注了他對時事審時度勢後的折衝。如赤壁戰後，孫權雖曾同意周瑜趁曹魏赤壁初敗，東吳大膽取蜀的方略，但當劉備至京口見孫權，周瑜主張將劉備軟禁，孫權又以「曹公在北方，當廣寧英雄，又恐備難卒制，故不納」[28]，顯見孫權雖信任周瑜，但對敵我情勢的判斷全面，使他對周瑜諫言的良窳有著清楚的認識。又如夷陵之戰，孫權竟能獨排眾議，大膽重用青年書生陸遜，致破蜀擋魏，終於底定荊州，完成「吳中對」的擘畫。無怪乎陳壽在〈陸遜傳〉末讚曰：「陸遜春秋方壯，威名未著，摧而克之，罔不如志。余既奇遜之謀略，又歎權之識才，所以濟大事也。」[29]

至於對魯肅、呂蒙處理荊州事不同態度的全然接納亦同。如孫權同意周瑜取蜀，肇因於曹操新敗，短時間內不可能再向東南用兵的局勢揣度，但魯肅繼任後，曹操元氣已復，若武力制蜀，恐遭曹魏背後偷襲，在北方敵人威脅未減的情況下，遂轉而同意魯肅平分荊州予劉備以樹操敵的建議。而孫權的這一決策消息傳到曹魏後，竟使正在寫文章的曹操聞訊「落筆於地」。又如襄樊之戰爆發後，關羽北伐連戰連勝，孫權考慮到一旦曹魏滅，則東吳必不保，因此趁曹魏連敗之際，暗和曹魏圖取關羽。此一外交策略的轉折，助東吳在魏、蜀打得兩敗俱傷的當下，成功奪得中南荊州全境。武力奪荊州是呂蒙的主張，但對曹操「討羽以自效」卻是孫權的進一步決定，因爲他清楚，在奪取荊州的過程中，斷不能橫生枝節，故在三強鼎立下，只有先撫曹魏，以獲得成功圖荊的最大或然率。

總而言之，從「吳中對」確定了對荊州的勢在必得後，孫權付諸麾下的最高戰略指導就是極力圖取荊州，其人才的運用原則上，也以從謀劃荊州爲立基，尋機逐鹿天下爲終極，從周瑜、魯肅、呂蒙到陸遜，毫無二致，即便北方有曹魏威脅，孫權在荊州問題上，至多也僅止於與同樣對荊州垂涎的劉備平分疆域，從未放棄吳中對的初衷。至於對臣下處理荊州不同態度的取捨，乃全然出於順應時局變化考量，而其中心思維，則在於成功奪取荊州以前，以鼎立之勢自保，避免過早與強敵對決。因爲孫權清楚，只有占有

[27] 參見《三國志・吳書》卷四十六，〈孫破虜討逆傳〉，頁 1109。
[28] 參見《三國志・吳書》卷五十四，〈周瑜傳〉，頁 1264。
[29] 參見《三國志・吳書》卷五十八，〈陸遜傳〉，頁 1361。

荊州，方能穩立江東，只有穩立江東，才能進一步問鼎中原。

捌.結論

《三國志》作者陳壽曾這麼評價過孫權：「孫權屈身忍辱，任才尚計。」[30]

孫權因能屈身忍辱、審時度勢，故夷陵戰前，能暫時稱臣於曹魏，以避免東吳陷於兩線作戰之危境，在夷陵之戰前後，也屈身戰勝之姿態，主動派使請和於蜀漢，以持續吳蜀聯盟的可能。他這種因應時局而造就出的能屈能伸個性，與「任才尚計」結合，竟能在東吳的戰守策略運用上遊刃有餘。考究其原因，在專制時代，孫權以一國之尊固然可爲所欲爲，但若政策失當，也無法獲得大臣的支持，甚至在戰亂的時代，隨時都有可能面臨被臣下推翻的危險。但孫權很清楚東吳在三足鼎立下的最高戰略指導原則，故其一切作爲皆以實現這個戰略原則爲首要考量，自己是否受屈辱，就不是那麼重要。而這個戰略指導原則爲何呢？個人以爲，與其說是一般人說的「聯蜀抗魏」不如說是「掌握最佳戰略位置」以「聯蜀抗魏」則更爲完整。

後代研究三國的學者常有一種想法「曹魏有天時，東吳掌地利，蜀漢握人和」。「天時」純粹是一種機運，不完全爲人力所能強求。「人和」就當時來說，魏、蜀、吳其實在其統治區內都掌有此項優勢。剩下的就是「地利」——即戰略位置的爭奪。孫權以其外交與軍事策略的交互運用，成功的實現「吳中對」中，東吳立國於江左的一切憑藉。較之於蜀漢不計得失的單一聯盟策略與曹魏雖先掌握天時，並有較強大的國力，卻要隨時應付兩面作戰的左支右絀，東吳的戰守策略顯然是最成功的。這裡，個人想到了孔明在用兵策略上曾說過：「不知地理，不可爲將」。觀之孫權，雖是一位君王，但對於諸葛亮的這一卓見，卻作了最徹底的實現。

[30] 參見《三國志・吳書》卷四十七，〈吳主傳〉，頁 1149。

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清雲科技大學《清雲學報》徵稿辦法

92 年12 月15 日92-1-第四次行政會議通過
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