台大工業工程所-跨領域整合與創新高階主管碩士在職專班 跨領域整合與創新(四)」

Service Operations Management

Operations Management Simulation: Benihana

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Running a restaurant

Suppose you are the restaurant owner or manager...





- o Profitability
- Capacity utilization
- o Throughput
- Customer satisfaction
- o ...

Background

Suppose you have those facilities with a very high demand.



What limits those facilities' profitability or customer satisfaction?



Restaurant capacity

- If you have a restaurant with four tables with four chairs each, what is the restaurant's total capacity?
- If your demand far exceeds your capacity, will the capacity utilization of your restaurant be 100%?



o Any suggestions?

Why does capacity limit the profitability?



Dinning in Benihana

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https://www.youtube.com/watch?v=fD340w AWTH8

Virtual tour: https://www.youtube.com/watch?v=YfWOtDAi4qM

Bar area

Dinning area





Challenges

- o Batch Dining Room Customers
- o Design the Bar
- Change Dining Time
- Boost Demand with Advertising and Special Programs
- Use Different Type of Batching at Different Times
- Design Your Best Strategy





模仿真實世界過程或系統中的操作行為。透過電腦快速運算能力,來觀察整體系統及各組成元件的交互影響,以推論該系統的績效與特質作為決策參考。

■ 尋求模式的解

□ 數學解析解

□ 數值分析解

□ 模擬解



https://larspsyll.wordpress.com/2015/09/08/are-all-models-wrong/





何謂模擬?

模擬是針對存在或構想中之操作性系統行為,以電腦為構建基礎之數學或邏輯模式。然後在此實驗模式上:

□ 評估各種不同組合之決策

□ 透過模擬運作的過程瞭解整體系統的操作行為



模擬(Simulation)為一評估式模式(Evaluative Model), 而非求得最佳化模式(Optimal Model)。



為何需要模擬?

- 實際的系統還未存在
 建構未來的飛機場
- 實際的系統已經存在
 - □ 修改工廠的製造流程
 - □ 醫院的看診流程
- 分析或預測複雜處理行為
 生產線上的動態排程問題
- 數學模式無法提供分析或數值解
 非指數分配的多個服務者且等候有限的問題

模擬的優點

- 可以分析過於複雜的問題
- 可以觀察到數學解析解與數值分析解無法觀察到的細節
- 可以為系統實驗做小幅度的微調
- 可用來驗證數學解析解與數值分析解的可信程度
- 容易展示結果的方法

...

模擬的缺點

- 時常會非常耗時
- 模擬的結果通常是「隨機的」(可能造成對系統的誤解)
- 當要求解一「確定的」問題時,可能存在其他方法較好的求解 方法

· · · ·

模擬的角色

- 解說(Explanatory devices)
 □用來定義或詮釋一個系統流程行為
- 設計評估(Design assessors)
 - □ 評估不同的建議性方案
- 分析(Analysis vehicles)
 分析影響系統行為的重要因子
- 預測(Predictors)
 - □ 用來預期可能發生的狀況以規劃未來發展





排多隊?



https://tw.appledaily.com/headline/daily/20120831/34477101







裝配研究可以釐清所有元件並 訂定合適的組裝順序



剖面工具可以幫助我們仔細診察 細節的關鍵區域

空間模擬

- 我們可以使用空間模擬軟體來建構3D型態的模型,以展示廠內 之機台佈置與工作區域的設計
- 3D規劃圖可以幫助我們提早發現錯誤
- 結果容易展示且有助於部門間的溝通

空間模擬案例-加工廠區



eM-Workplace NT 可以描繪出生產線 整體3D畫面

□ 大部區塊佈置

□ 細部組織佈置

□ 細節流程佈置

客製化的3D元件查詢 系統可以更快更有效 率的將生產線設計圖 陳列出來

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空間模擬功能

- 運用模型來模擬不同體型與性別的有效工作環境限制
- 最佳化作業流程時間
- 多種人體工學分析模式,例如:姿勢分析、能量消耗與負重施 力分析等等
- 實用模擬結果於動態的作業動作分析指南



■ 運用模型之模擬評估企業決策



流程模擬案例-含儲撿貨策略

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流程模擬案例--手術房排班

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流程模擬案例-汽車生產廠設施規劃比較



模擬在製造業的應用

- 瓶頸分析
- 生產線平衡分析
- 接單決策分析
- 產能分析
- 設施規劃分析
- 成本分析
- 產出分析
- 投資分析

- 顧客服務水準分析
- 存貨政策分析

- 設備參數分析
- 資源排班分析
- 廠內外物流分析
- 排程、派工模擬
- 零庫存系統模擬
- 企業再造工程模擬

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模擬在服務業的應用

- 企業流程改善模擬
- 商業自動化模擬
- 物流倉儲模擬
- 銀行服務流程模擬
- 投資決策模擬
- 新產品開發流程模擬
- 物流系統最佳化分析
- 網路效率評估
- 空間規劃模擬
- 後勤支援模擬

- 配銷系統模擬
- 拍賣市場模擬
- 零庫存系統模擬
- ISO 9000品管流程模擬分析

模擬在交通運輸業的應用

■ 發展軌道運輸

- 整合公路網路
- 運輸管理決策
- 發展大眾運輸
- 加強運輸安全
- 研發運輸技術
- 派車模擬
- 交通工具排班模擬
- 停車場設施規劃
- 車流、人潮模擬

- 物流中心動線規劃
- 快遞服務業模擬
- 農產運銷模擬

模擬在軍事上的應用

- 兵棋作戰模擬
- 派車模擬

- 醫務管理模擬
- 運輸補給模擬
- 後勤支援模擬

實例:單一服務者系統

 物件到來符合 指數分配

- 服務時間符合 指數分配
- 單一物件來源
- 單一服務員
- 在製品存放區 容量無限

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離散事件的模擬

- 離散事件模擬考慮在一系統之模式裡,時間的描述是由系統狀態瞬間改變的時間點所決定
- 舉例:單一服務者系統
- 此模擬是為了要得到未來改變系統狀態之事件發生時的最接近時間點







Operations Management Simulation: Benihana

https://hbsp.harvard.edu









How to Play Benihana Simulation

- Select the challenge type (1 to 6)
- o Choose the parameter options required for the related challenge
- Click 'SIMULATE' button to run the scenario (20 runs of simulation will appear in the upper left corner box)
- To show the animation, click on any run listed in the box (while the animation is running, the performance box at the lower left corner is also being updated simultaneously)
- To show the recap of scenarios have been done, click 'View Data' option in the upper left corner box (to go back to see the animation, click 'View Animation')

Challenge 1: Batch Dining Room Customers

Options

o Batching

Sending customers from the bar to the dining room in groups of eight

No batching

Sending customers from the bar to the dining room based on the size of their party

Discussion:

- How does batching affect throughput?
- What are the potential disadvantages of batching?

Challenge 1: Batch Dining Room Customers (Batch)



Challenge 1: Batch Dining Room Customers (No Batch)



Challenge 1: Batch Dining Room Customers

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6

Challenge 1: Batch Dining Room Customers

- Batching offers both higher profitability and increased utilization.
- Batching results in increased total dinner revenue even if fewer drinks are sold.
- Batching reduces number of lost customers.

- Selection of batching affects the entire operations.
- Batching might reduce customers' satisfaction.

Challenge 1: Batch Dining Room Customers



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Challenge 2: Design the Bar

Bar mainly serves as a "buffer" for the demand.

Discussion:

- > What is the optimal size of the bar that maximizing profitability?
- Is having a bar always a good idea?







87 bar seats, 10 tables

Challenge 2: Design the Bar

		Group 1	Group 2	Group 3	Group 4	Group 5	Group	6
	Batch							
	No batch							
								55
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Challenge 3: Change Dining Time

By controlling some variables through its menu, ordering procedure, food preparations, and 'live-cooking' style restaurant, Benihana is able to adjust its customers dining time.



Challenge 3: Change Dining Time

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Open to 7pm						
7pm-8pm						
8pm-10:30pm						

Challenge 3: Change Dining Time



Challenge 4: Boost Demand with Advertising and Special Programs

Options

.

- Advertising budget: 1 4 times normal budget
- o Advertising Campaign: awareness building, discount promotion, happy hour
- **Restaurant Opening Time:** one hour earlier, normal opening time, one hour late 0

What are the best cho	ices to increase the profitability?	
> Which works and does	s not work? Why?	
nallenge 4: Boost Demand with	Advertising and Special Programs	
nallenge 4: Boost Demand with ore information Advertising Budget	Advertising and Special Programs Advertising Campaign	Restaurant Opening Time
Advertising Budget	Advertising and Special Programs Advertising Campaign	Restaurant Opening Time
Advertising Budget none 4x 1x normal budget	Advertising and Special Programs Advertising Campaign Awareness Building Discount Promotion	Restaurant Opening Time 5:00 pm 6:00 pm

Challenge 4: Boost Demand with Advertising and Special Programs

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Advertising budget						
Advertising campaign						
Restaurant opening time						

Challenge 4: Boost Demand with Advertising and Special Programs more information

Adverti	sing Budget		
none	-	- 4x	
	1x normal budget		

Advertising	Campaign
-------------	----------

Happy Hour

۲	Awareness Building
0	Discount Promotion

notio	n	



5:00 pm

6:00 pm

Restaurant Opening Time

and Special Flograms	Summary Finan	cial Cust. I	lost Served	
1 0	Bar Usage		Dining Room L	Jsage
	Drinks Sold	435.84	Dinners Served	406.35
	Avg. Cust.	15.8	Tables Served	51.25
Spending 3 times normal budget	Max Cust.	55	Avg. Tables in Use	10.00
openaing e timee normal subget	Avo, Wait	28.14	Avg. Dining Time	74.52
Discount promotion	Max Wait	47.55	Avg. Cust.	79.2
Biocount promotion	Lost Cust.	89	Max Cust.	112
Opening time at 5:00 PM	Avg. Drinks Per Cust.	2.34	Avg. Utilization	70.74%
	Revenue	\$4,325.65	Nightly Profit	-\$265.95
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VS.	Summa <mark>r</mark> y Finan	cial Cust. I	.ost Served	
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 Spending 2 times normal budget Happy hour Opening time at 5:00 PM 	Summary Finan Bar Usage Drinks Sold Avg. Cust. Max Cust. Avg. Wait Max Wait Lost Cust.	cial Cust. 1 279.65 10.14 50.25 10.41 44.95 22	ost Served Dining Room I Dinners Served Tables Served Avg. Tables in Use Avg. Dining Time Avg. Cust. Max Cust.	Usage 385.6 48.65 9.17 65.69 72.7 112
 Spending 2 times normal budget Happy hour Opening time at 5:00 PM 	Summagy Finan Bar Usage Drinks Sold Avg. Cust. Max Cust. Avg. Wait Max Wait Lost Cust. Avg. Drinks Per Cust.	cial Cust. 1 279.65 10.14 50.25 10.41 44.95 22 0.87	Lost Served Dining Room I Dinners Served Tables Served Avg. Tables in Use Avg. Dining Time Avg. Cust. Max Cust. Avg. Utilization	Usage 385.6 48.65 9.17 65.65 72.7 112 64.94%

Challenge 5: Use Different Type of Batching at Different Times

Options (enhancing the first challenge)



Challenge 5: Use Different Type of Batching at Different Times

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Open to 7pm						
7pm-8pm						
8pm-10:30pm						
Challenge 5: Use Di	fferent Types	of Batching at	Different Times			
Batching Type Open to 7pm		Batching T 7pm to 8pr	ype n (Peak Time)		Batching Type 8pm to 10:30pm	
no batching tables of 8	tables of 4 to 8 4 share a table	 no batc tables of 	hing tabl	es of 4 to 8 are a table	 no batching tables of 8 	 tables of 4 to 8 4 share a table 65



Challenge 5: Use Different Type of Batching at Different Times



Dining room utilization

.8%

%

%

12.2%











- 將欲輸入模式之資料加以分析。基本上是針對模擬之輸入參數
 利用統計方法加以分析
- 模擬輸入分析的主要目的
 - □ 分析參數資料的統計分配
 - □ 避免由於輸入不適當的參數資訊而影響到模擬結果。不當的輸入資 料會導致無意義的結果(Garbage In, Garbage Out)

確定性與隨機性資料輸入

■ 確定性資料

□ 資料為固定值 (例如:每位顧客用餐時間均為一小時)

■ 隨機性資料

□ 資料符合統計機率分配模型

□ 造成模擬結果不確定性之主因

隨機資料符合之統計分配

■ 可由理論或是經驗求出結果

■ 考慮統計分配的範圍

□ 雙邊皆無界(e.g.常態分配)

- □ 只存在正值(e.g.指數分配)
- □存在上下界(e.g.均匀分配)

成功的模擬專案

模擬專案的形成

- 模擬專案的選擇
- 模擬軟體、硬體及輔助軟體
 - □ 模擬語言(Simulation language)
 - □ 模擬器(Simulator)
 - □ 模擬工具箱(Simulation toolkit)
- 與軟體供應商或顧問公司進行討論
- 模擬團隊的組成

□ 專案領導人、模式建構人員、模擬專家、模式使用者及資料提供者



模式驗證(Verification)與確認(Validation)

- 模式驗證(Verification)
 - □ 模擬程式是否正確?
- 模式確認(Validation)
 - □ 模擬模型是否合乎所要模擬的環境?

尋找合適統計分配之方法

- Step1.由一取得之資訊猜測符合之統計分配
 - □ 樣本平均數
 - □ 樣本標準差
 - □ 樣本變異係數
- Step2.估計參數並做適配度檢定
 - □ 卡方適配度測試 (Goodness of Fit Test)
 - □ K-S檢定(Kolmogorov-Smirnov Test)

模擬輸出分析

- 將模擬所產生的資料加以分析。基本上是針對模擬出的觀察值 利用統計方法加以分析
- 模擬輸出分析的主要目的
 - 藉由特定參數或模式的輸入,得到一些如平均值、變異數等衡量指標,來分析及了解目前系統的參數行為,或用來預測仍在設計階段的系統可能的行為
 - □ 藉利用各種不同的參數或模式輸入,來比較各種不同系統的績效, 以作為決策的參考

單一系統-中斷式系統模擬輸出分析

- 中斷式系統是指將系統模擬時間限定在一定的範圍內
- 利用不同隨機變數,經過R次的模擬,產生R個觀察值
- 平均值之點估計

$$\Box \quad \hat{\theta} = \frac{1}{R} \sum_{r=1}^{R} \hat{\theta}_r$$

■ 區間估計

$$\square \quad \hat{\theta} - t_{\underline{\alpha}} \quad \hat{\sigma}(\hat{\theta}) \le \theta \le \hat{\theta} + t_{\underline{\alpha}} \quad \hat{\sigma}(\hat{\theta})$$

單一系統-非中斷式系統-穩態模擬輸出分析

- 非中斷式系統是指連續執行一段很長的時間的系統
- 通常此系統有興趣的是分析長期穩態,也就是不受起始狀態的 系統特性。亦即所謂的穩態模擬



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兩系統間之比較分析(I)

- 模擬常被用來分析不同方案之間的優劣
- 可採用信賴區間法來分析兩方案間的績效表現差異(θ₁-θ₂)
- 信賴區間的計算

lower bound $\leq \theta_1 - \theta_2 \leq upper bound$

雨系統間之比較分析 (II)

- 可能的結果
 - □ 若 $\theta_1 \theta_2$ 的信賴區間完全落在零點的左方,則有充裕的證據說明 $\theta_1 - \theta_2 < 0$,即有充分的信心說明 $\theta_1 < \theta_2$
 - □ 若 $\theta_1 \theta_2$ 的信賴區間完全落在零點的右方,則有充裕的證據說明 $\theta_1 - \theta_2 > 0$,即有充分的信心說明 $\theta_1 > \theta_2$
 - □ 若 θ₁ θ₂的信賴區間包含零點,則沒有充分證據顯示兩個系統之間 有顯著差異



- 模擬的簡介
- 模擬軟體的應用
- 服務業的營運管理-模擬分析
- 模擬輸入及輸出分析
- 成功的模擬專案

Simulation of the Birthday Paradox



Simulation of the Birthday Paradox

	1	2	3	4	5	6	7	8	9	1 0	1 1	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 9	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	3 0	3 1
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Thank you Any questions or comments...? Please feel free to contact me at ihong@ntu.edu.tw

