YIELD MANAGEMENT 2

Service management
Fitzsimmons & Fitzsimmons

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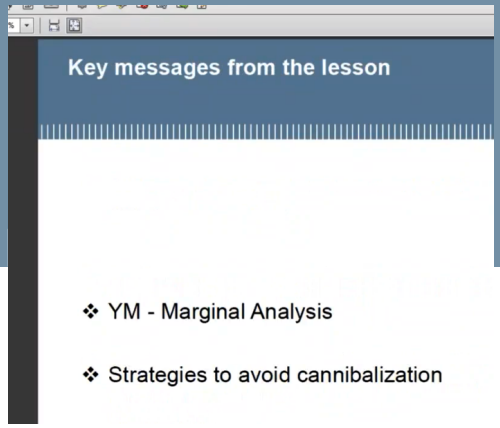
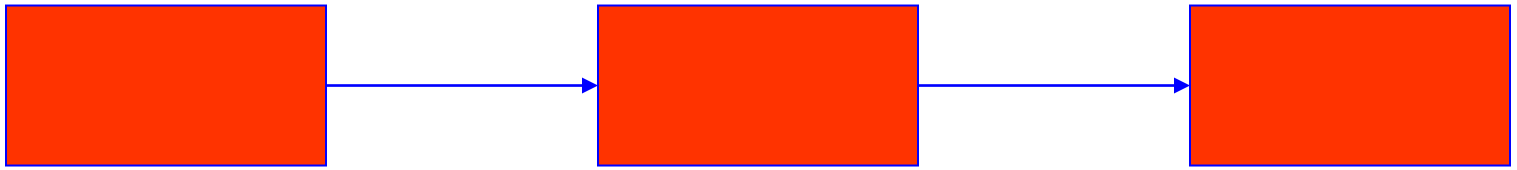
Protection level sizing



	Ticket full	Ticket discounted
margin	Mf	Md
Averge quantity	X1	X2

Event sequence



Demand for discounted seats.

Accept/reject request for discounted seats

Demand for full price seats

S_1=Protection level

A_2=C-S_1 Capacity allocation, low cost.

Protection level definition

1. Marginal Analysis

2. Heuristic Expected Marginal Seat Revenue (EMSR)

1. Marginal analysis approach

X_1 = Demand for full price unit

C_u = Cost to underestimate the demand of a full price unit

هزینه وقتیه که واکینگ باید بدیم و جبران کنیم

C_o = Dost to overestimate the demand of a full price unit

کمتر فول پرایس دادیم و مشکل اینه باید دیسکونتد بفروشیم

1. Marginal analysis approach

Balance between underestimate exspected cost and overestimate expected cost

P(under.) *Underestimate cost $\geq$ P(over.) *Overestimate cost.

احتمال

$$P(X_1 \geq S_1) * C_u \geq P(X_1 < S_1) * C_o$$

$$[1 - P(X_1 < S_1)] * C_u \geq P(X_1 < S_1) * C_o$$

$$P(X_1 < S_1) \leq \frac{C_u}{C_u + C_o}$$

دیمند پروتکشن لول

اس وان تعداد صندلیه که میخوایم به فول پرایس الوکیت کنیم.

Protection level: marginal analysis

In our case:

C_u=Pf-Pd

C_o=Pd

$$P(X_1 < S_1) \leq \frac{C_u}{C_u + C_o}$$

In the game

(Hp: variable costs are negligible)

C_u= 1100-300 = 800 lost opportunity to full price

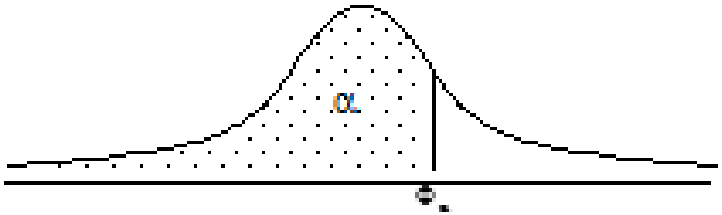
C_o= = 300 lost opportunity to discounted

P(X1<S1) $\leq$ 800/1100 = 0,727

$\Rightarrow \Phi\alpha = 0,6$

S = PL = $\mu + \Phi\alpha * \sigma$ (میانگین، فای الفا، سیگما (استندارد دوییشن)

= 43 + 0,6 * 6 = 47 تا برای فول پرایس نگه میداریم تا هزینه مین و ماکس پرافیت رو داشته باشیم ۴۷.



Φ_α	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0,50000	0,50399	0,50798	0,51197	0,51595	0,51994	0,52392	0,52790	0,53188	0,53586
0.1	*0,53983*	*0,54380*	*0,54776*	*0,55172*	*0,55567*	*0,55962*	*0,56356*	*0,56749*	*0,57142*	*0,57535*
0.2	0,57926	0,58317	0,58706	0,59095	0,59483	0,59871	0,60257	0,60642	0,61026	0,61409
0.3	*0,61791*	*0,62172*	*0,62552*	*0,62930*	*0,63307*	*0,63683*	*0,64058*	*0,64431*	*0,64803*	*0,65173*
0.4	0,65542	0,65910	0,66276	0,66640	0,67003	0,67364	0,67724	0,68082	0,68439	0,68793
0.5	*0,69146*	*0,69497*	*0,69847*	*0,70194*	*0,70540*	*0,70884*	*0,71226*	*0,71566*	*0,71904*	*0,72240*
0.6	0,72575	0,72907	0,73237	0,73565	0,73891	0,74215	0,74537	0,74857	0,75175	0,75490
0.7	*0,75804*	*0,76115*	*0,76424*	*0,76730*	*0,77035*	*0,77337*	*0,77637*	*0,77935*	*0,78230*	*0,78524*
0.8	0,78814	0,79103	0,79389	0,79673	0,79955	0,80234	0,80511	0,80785	0,81057	0,81327
0.9	*0,81594*	*0,81859*	*0,82121*	*0,82381*	*0,82639*	*0,82894*	*0,83147*	*0,83398*	*0,83646*	*0,83891*
1.0	0,84134	0,84375	0,84614	0,84849	0,85083	0,85314	0,85543	0,85769	0,85993	0,86214
1.1	*0,86433*	*0,86650*	*0,86864*	*0,87076*	*0,87286*	*0,87493*	*0,87698*	*0,87900*	*0,88100*	*0,88298*
1.2	0,88493	0,88686	0,88877	0,89065	0,89251	0,89435	0,89617	0,89796	0,89973	0,90147
1.3	*0,90320*	*0,90490*	*0,90658*	*0,90824*	*0,90988*	*0,91149*	*0,91308*	*0,91466*	*0,91621*	*0,91774*
1.4	0,91924	0,92073	0,92220	0,92364	0,92507	0,92647	0,92785	0,92922	0,93056	0,93189
1.5	*0,93319*	*0,93448*	*0,93574*	*0,93699*	*0,93822*	*0,93943*	*0,94062*	*0,94179*	*0,94295*	*0,94408*
1.6	0,94520	0,94630	0,94738	0,94845	0,94950	0,95053	0,95154	0,95254	0,95352	0,95449
1.7	*0,95543*	*0,95637*	*0,95728*	*0,95818*	*0,95907*	*0,95994*	*0,96080*	*0,96164*	*0,96246*	*0,96327*
1.8	0,96407	0,96485	0,96562	0,96638	0,96712	0,96784	0,96856	0,96926	0,96995	0,97062
1.9	*0,97128*	*0,97193*	*0,97257*	*0,97320*	*0,97381*	*0,97441*	*0,97500*	*0,97558*	*0,97615*	*0,97670*
2.0	0,97725	0,97778	0,97831	0,97882	0,97932	0,97982	0,98030	0,98077	0,98124	0,98169
2.1	*0,98214*	*0,98257*	*0,98300*	*0,98341*	*0,98382*	*0,98422*	*0,98461*	*0,98500*	*0,98537*	*0,98574*
2.2	0,98610	0,98645	0,98679	0,98713	0,98745	0,98778	0,98809	0,98840	0,98870	0,98899
2.3	*0,98928*	*0,98956*	*0,98983*	*0,99010*	*0,99036*	*0,99061*	*0,99086*	*0,99111*	*0,99134*	*0,99158*
2.4	0,99180	0,99202	0,99224	0,99245	0,99266	0,99286	0,99305	0,99324	0,99343	0,99361
2.5	*0,99379*	*0,99396*	*0,99413*	*0,99430*	*0,99446*	*0,99461*	*0,99477*	*0,99492*	*0,99506*	*0,99520*
2.6	0,99534	0,99547	0,99560	0,99573	0,99585	0,99598	0,99609	0,99621	0,99632	0,99643
2.7	*0,99653*	*0,99664*	*0,99674*	*0,99683*	*0,99693*	*0,99702*	*0,99711*	*0,99720*	*0,99728*	*0,99736*
2.8	0,99744	0,99752	0,99760	0,99767	0,99774	0,99781	0,99788	0,99795	0,99801	0,99807
2.9	*0,99813*	*0,99819*	*0,99825*	*0,99831*	*0,99836*	*0,99841*	*0,99846*	*0,99851*	*0,99856*	*0,99861*

Few messagges

- It would be possible to saturate the hotel selling all rooms at a reduced rate. In this way, however, the profit would not be maximized. Hence, it could be risky against a potentially superior margin.
- Uncertainty and variability have to be managed: overbooking and risk on the fixing of the protection level.
- Having information on the past history is essential to set a yield management system, as well as having good demand forecasts. The information system is the keystone for the success of this management approach.
- Abilities to segment effectively the different types of customer and to know in advance is crucial and the operations have to exploit them (e.g. Japanese customers usually do less no-show than Italian ones).
- It's important to pay a lot of attention to the choice of prices.

Few elements to segment the demand

Some elements of segmentation to avoid cannibalization of rates:

- Restrictions on the purchase
  - Delete option
  - Number of units
- Purchase volume
  - Single purchase vs buying group
- Duration of use
  - Stay 1 day vs weekly stay
- Customer "Value”

Yield management system implementation - Example

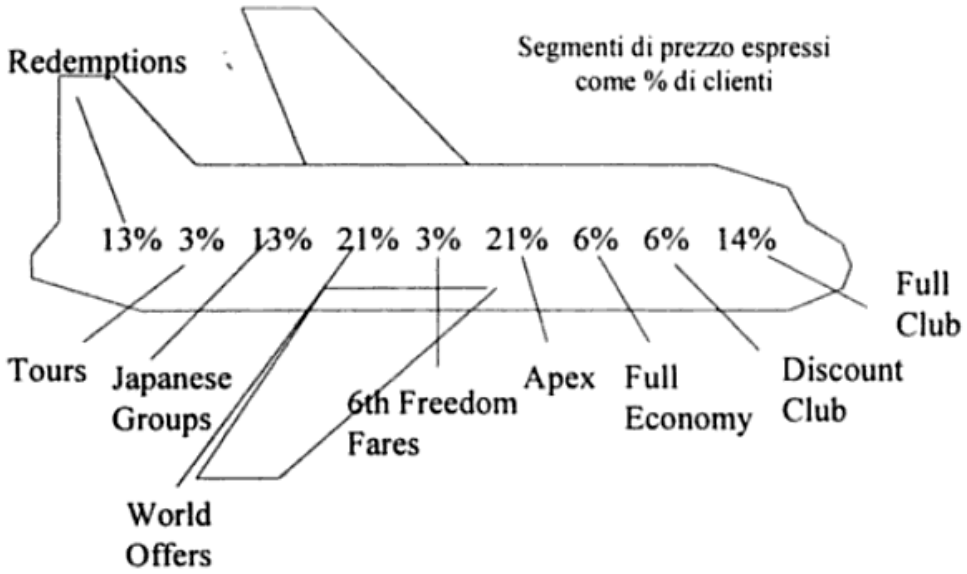
The case of an English airline

Although the majority of customers tend to look for the best price, British Airways seeks to encourage them to buy the most expensive places, as you approach the departure date (trade up). To do this, British Airways must make less attractive the reservation in advance for clients who are traveling on business, through mechanisms such as the inclusion of a Saturday night, a reservation in advance, for example, three months, a policy that excludes repayments, changes in person, itinerary changes, and no one stop on the trip. The effectiveness of this form of price discrimination depends on the ability to restrict the ability for customers to move outside of their respective segments. The system also includes a British Airways forecast module and a system of decision support. It also takes into account: the balance of the network (so the flight for a passenger in coincidence will have a different price than that of a passenger who buys only that flight), the percentage of customers who do not show up at the start (no-show), and in practice tries to apply the optimal price depending on the willingness to pay of different customer segments. The result is usually the price of flying is not segmented into two or three levels (for example, business class and economy class), but in nine or more segments (price levels), where the price segment is often more lucrative private about 20% of the total seats sold.

(Leonardo Buzzavo, Andrea Stocchetti, 2001. Marketing, Technology, globalization. The challenges of global competition and digital technologies for marketing and. Franco Angeli)

Yield management system implementation - Example

The British airways system generates around 330mln pounds (500 mln euros) as annual profit



Fonte British Airways

Yield management system implementation - Example

- The case of a hotel chain. 4-rates: groups, promotions/vacation packages, corporate, transient.

- After having defined the rates for each customer segment and having studied available forecasts of the demand for each of these segments, it is possible to define the level-use necessary to close each of the discount's level. As parameter you can use the percentage of rooms sold. For example:
  - From 0 to 30% sold rooms→ all rates are available
  - From 30 to 50% sold rooms→ lowest promotional rate is closed (i.e.group)
  - From 50 to 80% sold rooms → all special rates are closed but corporate rate
  - From 80 to 100% sold rooms → only full rate rooms are available.
- Note that there is an increase in tariffs. Simply, as the number of occupied rooms increases, most discounted rates of the categories are closed to the sale, to increase profits. (Salerno, 2006).

Rate closing (Source: ACCOR)

1. Marginal analysis approach

Protection level is used for all cases when you want to protect some capacity for more profitable customers which will probably arrive later on.

Other applications

- Number of dresses of a new collection
- Number of newspapers to buy to resell
- Amount of bread to prepare

An example

Describe how you would determine the number of dresses to be ordered for next spring-summer collection, considering:

- the expected demand is distributed as a normal distribution with mean 100 and standard deviation of 20;

- dresses ordered but not sold at the end of the season are all sold by lowering the selling price by 50%, from 300€/u to 150€/u (the purchase cost is 160 euro per unit).

1. Marginal analysis approach

Cost of overestimating = the cost associated with having ordered an item in excess of those that were sold (cost associated with having to sell at a discount the excess unit that I bought)

- Overestimation cost: 160€/unit - 150€/unit
- Overestimation cost =10€/unit

1. Marginal analysis approach

Cost of underestimating = the cost associated with the non-sale of an item that I purchased for having underestimated the demand (lost margin for stock-out of the article).

- Underestimation cost: 300€/unit – 160€/unit

- Underestimation cost: 140€/unit

Protection level determination

Protection level determination:

$$P(X_1 < S_1) \leq \frac{C_u}{C_u + C_o} = 0.9333$$

Number of articles to buy in advance:

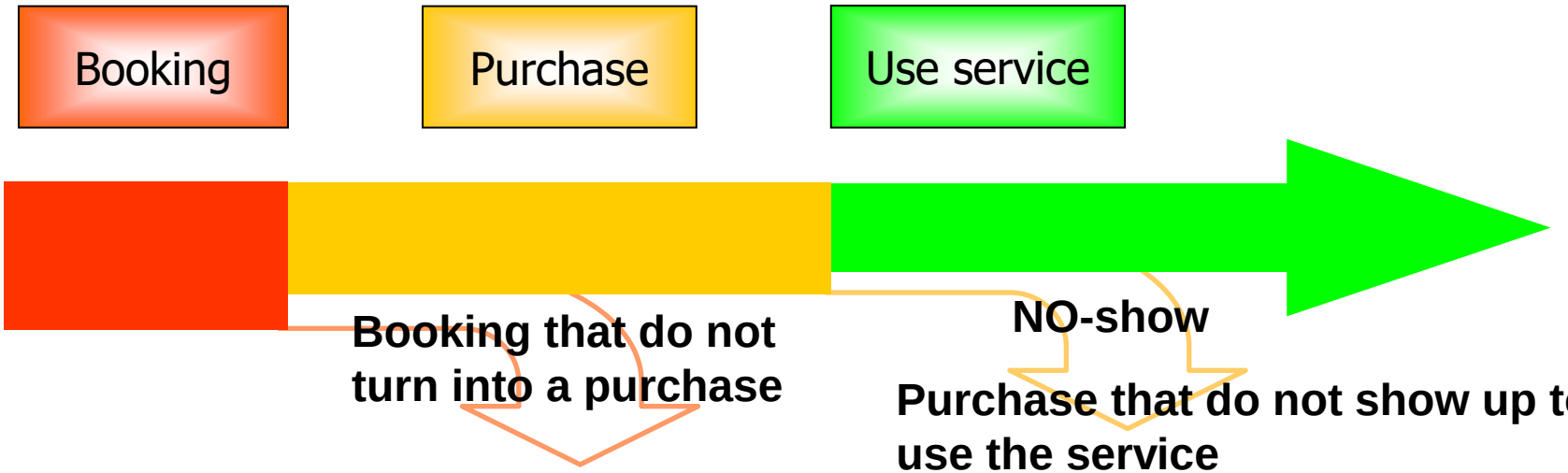
- $S = \mu + k * \sigma$
- $S = 100 + 1.5 * 20 = 130$ unit

Overbooking
- Introduction

Overbooking can be used in two situations:

- Overbooking, due to the fact that not all bookings become a sale;
- Overbooking of sold tickets over capacity (Overselling), due to the fact that not all of the ones who bought the ticked then use the service.

Overbooking
- Introduction



1) Define the number of units to sell to protect from NO-SHOWs

2) Define the number of reservations to be taken to protect from those who do not turn into purchases

Overbooking
- Introduction

The overbooking can be applied to 2 decision points

- Overbooking on the **number of reservations**: accept a number of reservations higher than the service that is able to provide
  - ❖in order to protect themselves from the reservations that do not turn into purchases

- Overbooking on the **sales**: selling a number of units that is bigger than actual capacity
  - ❖in order to protect from the effects of no show

Overbooking
- Introduction

- The application of the types of overbooking depends on the process followed by the each services company.

process number 3 (and 2)

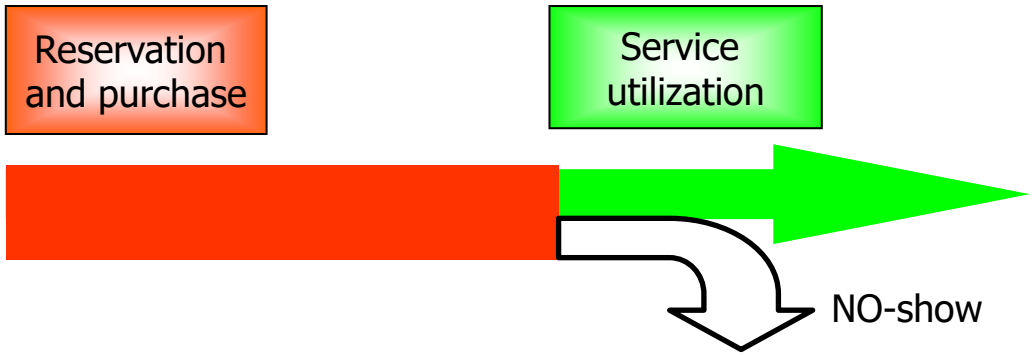
- In the following slides, we will refer to process type 3, but it is valid also for process type 2 and, if applied in sequence, also to process type 1

Overbooking
- Introduction

- Analysis on the mean values
- Analysis with calculation paper
- Marginal analysis
- Setting the level of service (not **YM**)

Static method

- Dynamic overbooking



Overbooking
- Average values approach

$$BL = \frac{C}{p}$$

BL= Booking limit

C= capacity

p= probability that the one who has booked a ticket, then buys it.

- Pros
  - Easy to understand and to implement
- Cons
  - Does not take into consideration costs

Overbooking
- Fixed service level

- You want to set the level of service to be provided to customers (put a limit to the probability of "walking")

- It's not a YM technique

$$P(X > C) \leq l$$

$$\Rightarrow$$

$$1 - P(X \leq C) \leq l$$

$$\Rightarrow$$

$$P(X \leq C) \geq 1 - l$$

Probability that the number units in overbooking is greater than the number of no-show < X

Overbooking
- marginal approach

We continue to accept reservations until the expected margin on the last booking accepted is greater than or equal to the expected loss on the last booking

C_u= unit cost to underestimate no-show

C_o= unit cost to overestimate no-show

$$C_u P(Ovb \leq NS) \geq C_o * P(Ovb > NS)$$

$$C_u P(Ovb \leq NS) \geq C_o [1 - P(Ovb \leq NS)]$$

$$P(Ovb \leq NS) \geq \frac{C_o}{C_u + C_o}$$

The Yield Management Game

NUMBER OF ROOMS=100
WALKING COST= 500€

Average NO-SHOW=20%

St. Deviation=3

DISCOUNTED PRICE DEMAND:

Demand **over** exceeds capacity

Average price= 300 €

FULL PRICE PROTECTION LEVEL:

Protection level for full-rate= 47

from previous calculation

Rooms allocated to discounted-rate=
= 100 – 47 = 53

How many discounted bookings has the hotel to accept?

Overbooking
- Introduction

Overbooking can be used in two situations:

- Overbooking, due to the fact that not all bookings become a sale;
- Overbooking of sold tickets over capacity (Overselling), due to the fact that not all of the ones who bought the ticked then use the service.

In the game

$C_u = 300$

$C_o = 500$

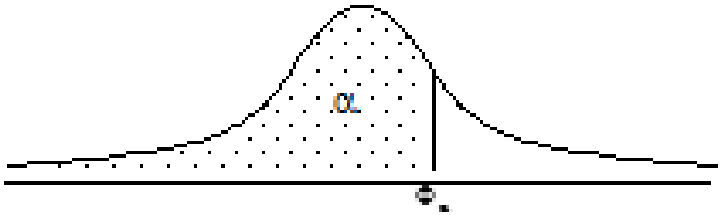
P(Ovb< **NS**)>= 500/800 = 0,625

$\Rightarrow \Phi\alpha = 0,32$

53 ta ke 20% no show daran

Ovb = $\mu - \Phi\alpha * \sigma = 53*0,2 - \Phi\alpha*\sigma$

= 10,6 - 0,32 * 3 = 9,64



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2.2	0,98610	0,98645	0,98679	0,98713	0,98745	0,98778	0,98809	0,98840	0,98870	0,98899
2.3	*0,98928*	*0,98956*	*0,98983*	*0,99010*	*0,99036*	*0,99061*	*0,99086*	*0,99111*	*0,99134*	*0,99158*
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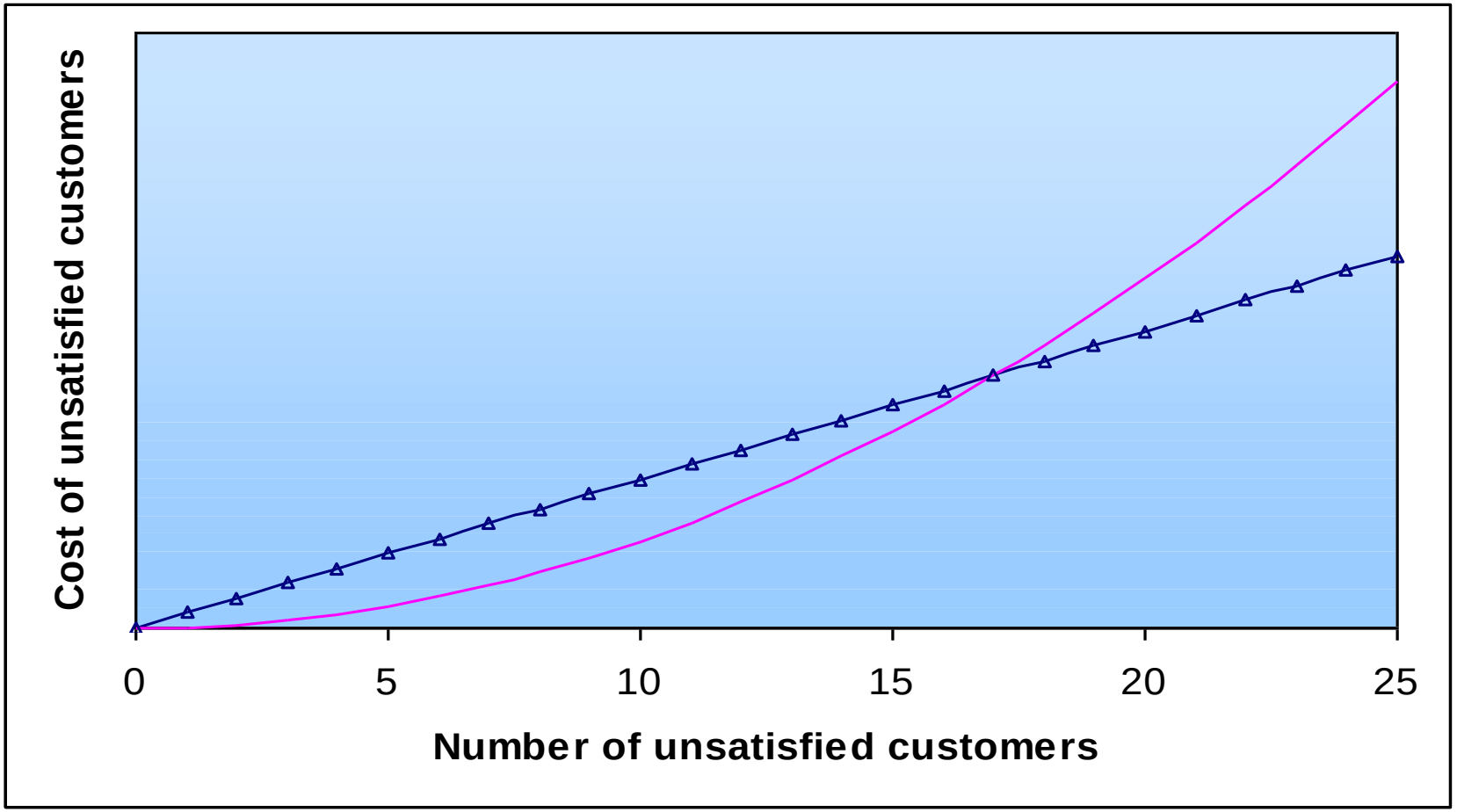
2.9	*0,99813*	*0,99819*	*0,99825*	*0,99831*	*0,99836*	*0,99841*	*0,99846*	*0,99851*	*0,99856*	*0,99861*

In reality, overbooking costs are not so linear



Difficulty in the implementation of YM systems

- Customers' reaction
  - Difficulty to understanding
  - Attempts to fool the system
- Conflicts of objectives among different business areas
- Cost/time Implementation
  - Cost of the information system
  - Difficulties/time/cost in data collection

Yield Management Impact

- Examples of improvements achieved:
  - American Airlines (1.4 bln.$ increas in turnover in a period of 3 year)
  - Hertz (turnover increase 1-5%)
  - Marriot Hotels (additional revenues 25 mln.$ in one year)
  - Royal Caribbean Cruise Line (20 mln.$ additional revenues in one year)

- Sectors adopting (and customising) these approaches are fast increasing. E.g. golf court

2. Heuristic EMSR (Expected Marginal Seat Revenue)

n # available rates

f_i unit revenue associated with rate i

$$f_1 \geq f_2 \geq \dots f_n$$

μ_i Average demand for rate i

σ_i^2 Variance in demand for rate i

ϑ_i Level of protection for class i and more expensive classes

D_i Available demand to pay rate i, or more expensive

2. Heuristic EMSR (Expected Marginal Seat Revenue)

Fix the level of protection for each of the classes / rates

2. Heuristic EMSR (Expected Marginal Seat Revenue)

$$\overline{f_i} * P(D_i \geq \vartheta_i) = f_{i+1}$$

Where…

$$\overline{f_i} = \frac{\sum_{j=1}^{i} \mu_j f_j}{\sum_{j=1}^{i} \mu_j}$$

Average rate of class i and more expensive

$D_i \sim$ N con $\overline{\mu}(i) = \sum_{j=1}^{i} \mu_j$ $\overline{\sigma}^2(i) = \sum_{j=1}^{i} \sigma_j^2$

2. Heuristic EMSR (Expected Marginal Seat Revenue)

$$\overline{f_i} * [1 - P(D_i < \vartheta_i)] = f_{i+1}$$

$$P(D_i < \vartheta_i) = 1 - \frac{f_{i+1}}{\overline{f_i}}$$

$$F(z_\alpha) = 1 - \frac{f_{i+1}}{\overline{f_i}}$$

$$\vartheta_i = \overline{\mu}(i) + z_\alpha \overline{\sigma}(i)$$

2. EMSR
- Example

Class	Rate	Mean	Variance
1	€ 100	30	50
2	€ 80	30	80
3	€ 40	50	120

Determine the protection level for classes 1 and 2

2. EMSR
- Example

Class	Rate	Mean	Variance
1	€ 100	30	50
2	€ 80	30	80
3	€ 40	50	120

Average weighted rates and aggregated Averages and Variances

	$\overline{f_i}$	$\mu(i)$	$\sigma^2(i)$
1	€ 100	30	50
2	€ 90	60	130
3	€ 67,30	110	250

Protection level for class 1

$$F(z_a) = 1 - \frac{80}{100} = 0.20 \Rightarrow z_a = -0.84$$

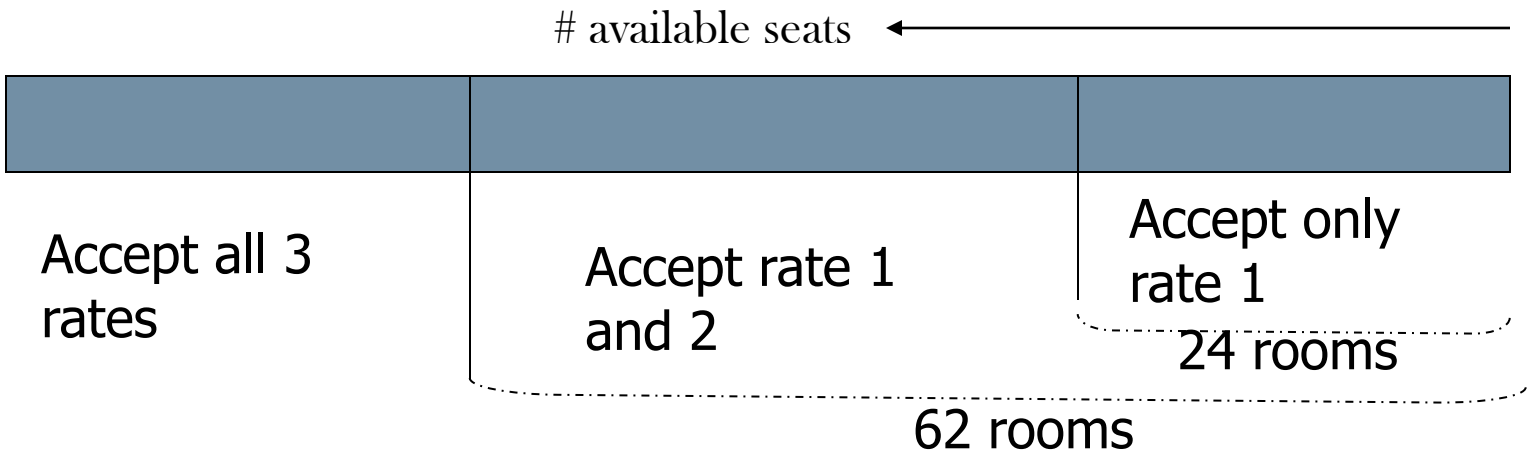
$$\Rightarrow J_1 = 30 - 0.84 * \sqrt{50} = 24.06 \approx 24 rooms$$

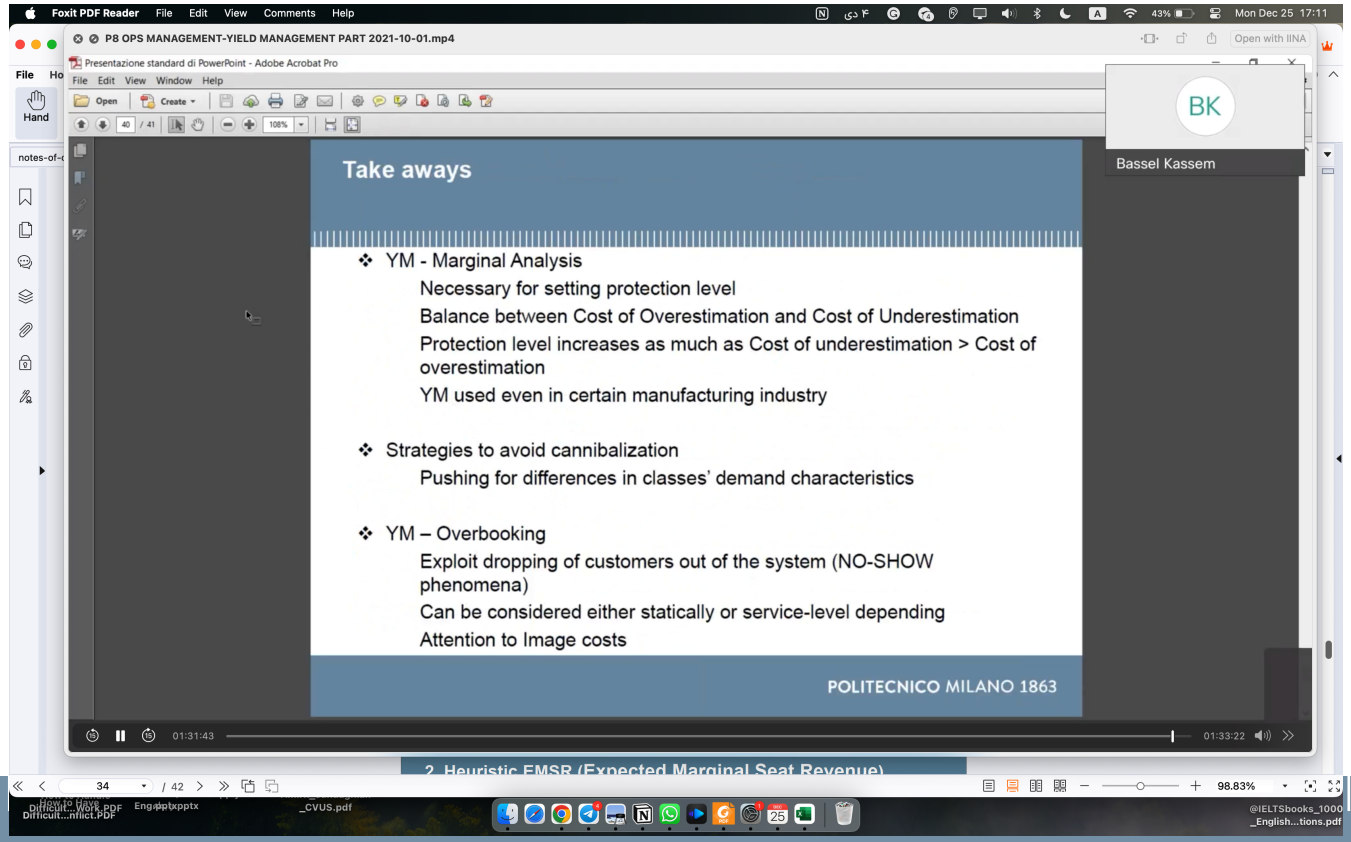
Protection level for classes 1 and 2 together

$$F(z_a) = 1 - \frac{40}{90} = 0.5556 \Rightarrow z_a = 0.14$$

$$\Rightarrow J_2 = 60 + 0.14 * \sqrt{130} = 61.6 \approx 62 rooms$$

There's no protection level for the most economic rate

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Take aways
YM - Marginal Analysis
Necessary for setting protection level
Balance between Cost of Overestimation and Cost of Underestimation
Protection level increases as much as Cost of underestimation > Cost of overestimation
YM used even in certain manufacturing industry
Strategies to avoid cannibalization
Pushing for differences in classes' demand characteristics
YM – Overbooking
Exploit dropping of customers out of the system (NO-SHOW phenomena)
Can be considered either statically or service-level depending
Attention to Image costs
POLITECNICO MILANO 1863
BK
Bassel Kassem
01:31:43
01:33:22
2. Heuristic EMSR (Expected Marginal Seat Revenue)
34 / 42
98.83%