



# AIRPORT SATISFACTION SURVEY

Team B-03

# Agenda

1. Introduction
2. Data Description
3. Methodology
4. Analysis Results and Interpretation
5. Managerial Implications



# Introduction

- Austin-Bergstrom International Airport's customer surveys
- Surveys are reported to
  1. Improve general customer satisfaction
  2. Target specific areas for improvement
- Analyze the key drivers of customer satisfaction



# Data Description

- Data.Gov, csv file, 2450 rows
- 33 survey questions with overall satisfaction, plus Date Recorded and Flight Departure Time
- Customer satisfaction scores for each attribute on a scale of 1-5
- Missing value and zero satisfaction (no opinion)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Quarter	Date recorded	Departure	Ground trans	Parking fee	Parking fee	Availability	Efficiency	Check-in	Courtesy	Wait time	Courtesy	Courtesy	Thorough	We
1Q15	2/5/2015	14:26	5	0	0	5	3	5	5	5	5	5	5	5
1Q15	2/5/2015	14:26	4	0	0	0	0	0	0	5	5	5	5	5
1Q15	2/5/2015	14:26	4	4	5	0	5	0	0	5	4	4	4	4
1Q15	2/5/2015	14:26	0	0	0	0	4	4	4	0	0	3	4	4
1Q15	2/5/2015	14:26	4	4	3	0	4	4	4	0	0	5	4	4
1Q15	2/5/2015	14:26	4	4	4		4	4	4	4	4	4	4	4
1Q15	2/5/2015	14:26	5	0	0	0	5	5	5	5	5	0	5	5
1Q15	2/5/2015	14:26	4	3	3	0	4	4	4	4	4	5	2	5
1Q15	2/5/2015	14:26	0	0	0	0	3	3	4	4	5	5	5	5
1Q15	2/5/2015	14:26	0	0	0	0	5	5	5	5	5	3	3	3
1Q15	1/12/2015	14:26	5	4	0	5	5	5	5	5	5	5	5	5
1Q15	1/12/2015	14:26	0	0	0	4	5	5	5	0	0	5	5	5
1Q15	1/12/2015	14:26	3	0	0	0	3	3	3			4	3	3
1Q15	1/12/2015	14:26	5	0	0	5	5	5	5	5	5	5	5	5
1Q15	1/12/2015	14:26	5	0	0	0	5	5	5	5	5	5	5	5
1Q15	1/12/2015	14:26	5	5	3	0	4	4	4	3	3	3	3	3
1Q15	1/12/2015	14:26	4	4	3	4	5	5	5	5	5	5	5	5
1Q15	1/12/2015	14:26	0										4	4
1Q15	1/12/2015	14:26	0	0	0	0	5	4	5	5	5	4	4	4
1Q15	1/12/2015	14:26	0	0	0	0	5	5	5	5	0	0	0	0
1Q15	2/5/2015	16:45	4	0	0	0	4	4	4	5	5	5	4	4
1Q15	2/5/2015	16:45	5	0	0	0	5	5	5	4	4	4	4	4
1Q15	2/5/2015	16:45	0	0	0	0	3	3	3	3	3	2	3	3
1Q15	2/5/2015	16:45	0	0	0	0	4	4	4	4	4	4	4	4
1Q15	2/5/2015	16:45	4	0	4	0	5	5	4	5	5	5		
1Q15	2/5/2015	16:45	5	0	0	0	5	5	5	5		5	5	5
1Q15	3/1/2015	17:05	3	0	0	0	4	4	4	4	4	4	4	4
1Q15	3/1/2015	17:05	0	0	0	4	5	5	5	5	5	5	5	5

# Methodology

- Imputing value for missing feature scores
  - “MICE” R package
  - Predictive mean matching (pmm)
- Deleting records with missing or zero (no opinion) overall satisfaction
  - Final dataset: 365 rows with 33 survey features, plus overall satisfaction, date recorded and flight departure time

A	B	C	D	E	F	G	H	I	J	K	L	M
Quarter	Date.recor	Departure	Ground.tr	Parking.far	Parking.far	Availability	Efficiency	Check.in.v	Courtesy.c	Wait.time	Courtesy.c	Courtesy.c
1Q15	2/5/2015	14:26	5	0	0	5	3	5	5	5	5	5
1Q15	2/5/2015	14:26	4	0	0	0	0	0	0	5	5	5
1Q15	2/5/2015	14:26	4	4	5	0	5	0	0	5	4	4
1Q15	2/5/2015	14:26	0	0	0	0	4	4	4	0	0	3
1Q15	2/5/2015	14:26	4	4	3	0	4	4	4	0	0	5
1Q15	2/5/2015	14:26	4	4	4	0	4	4	4	4	4	4
1Q15	2/5/2015	14:26	5	0	0	0	5	5	5	5	5	0
1Q15	2/5/2015	14:26	4	3	3	0	4	4	4	4	4	5
1Q15	2/5/2015	14:26	0	0	0	0	3	3	4	4	5	5
1Q15	2/5/2015	14:26	0	0	0	0	5	5	5	5	5	3
1Q15	#####	14:26	5	4	0	5	5	5	5	5	5	5
1Q15	#####	14:26	3	0	0	0	3	3	3	3	4	4
1Q15	#####	14:26	5	0	0	5	5	5	5	5	5	5
1Q15	#####	14:26	5	0	0	0	5	5	5	5	5	5
1Q15	#####	14:26	5	5	3	0	4	4	4	3	3	3
1Q15	#####	14:26	4	4	3	4	5	5	5	5	5	5
1Q15	#####	14:26	0	5	3	0	5	5	5	4	4	4
1Q15	#####	14:26	0	0	0	0	5	4	5	5	5	4
1Q15	#####	14:26	0	0	0	0	5	5	5	5	0	0
1Q15	2/5/2015	16:45	4	0	0	0	4	4	4	5	5	5
1Q15	2/5/2015	16:45	5	0	0	0	5	5	5	4	4	4
1Q15	2/5/2015	16:45	0	0	0	0	3	3	3	3	3	2
1Q15	2/5/2015	16:45	0	0	0	0	4	4	4	4	4	4
1Q15	2/5/2015	16:45	4	0	4	0	5	5	4	5	5	5
1Q15	2/5/2015	16:45	5	0	0	0	5	5	5	5	5	5
1Q15	3/1/2015	17:05	3	0	0	0	4	4	4	4	4	4

# Methodology

- Factor Analysis
- Regression (overall satisfaction as DV)
- K-means Clustering

# Factor Analysis Result

➤ 11 factors were selected

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8	Factor9	Factor10	Factor11
Ground transportation to/from airport		0.125			0.148		0.276				
Parking facilities					0.963		0.143				
Parking facilities..value.for.money.					0.922		0.136				
Availability of baggage carts		0.114		0.101	0.127		0.591				
Efficiency of check in staff	0.230	0.817					0.115				
Check in wait time	0.171	0.948									
Courtesy of check in staff	0.163	0.918									
Wait time at passport inspection	0.210	0.115						0.962			
Courtesy of inspection staff	0.313	0.112						0.778			
Courtesy of security staff	0.697	0.153						0.119		0.110	
Thoroughness of security inspection	0.848	0.111						0.125		0.132	
Wait time of security inspection	0.763	0.188					0.174	0.191			
Feeling of safety and security	0.889	0.135					0.150				
Ease of finding your way through the airport	0.123						0.756			0.140	
Flight information screens	0.106					0.137	0.562				
Walking distance inside terminal	0.145						0.791			0.120	
Ease of making connections			0.114	0.105		0.240	0.281				
Courtesy of airport staff	0.239	0.101	0.130	0.186		0.246	0.149			0.203	
Restaurants						0.973	0.138				
Restaurants..value.for.money.			0.117			0.801	0.179	0.181			
Availability of banks ATM money changing			0.407				0.536				
Shopping facilities			0.909			0.125	0.222				
Shopping facilities..value.for.money.			0.837			0.123	0.298			0.100	
Internet access			0.186	0.167			0.379		-0.171		
Business executive lounges			0.182				0.731				
Availability of washrooms				0.741			0.111	0.115			0.164
Cleanliness of washrooms				0.906				0.128			
Comfort of waiting gate areas	0.123	0.105		0.519			0.114				0.401
Cleanliness of airport terminal	0.194			0.227				0.297			0.649
Ambience of airport	0.180			0.156		0.105		0.170			0.854
Arrivals passport and visa inspection										0.947	
Speed of baggage delivery	0.156	0.159	0.172	0.132			0.143			0.242	
Customs inspection							0.154			0.740	

# Factor Analysis Result

➤ We are able to name all the 11 factors

1. Security (security checking process)
2. Check in (Check in / ticketing process )
3. Shopping
4. Washroom
5. Parking
6. Restaurants
7. Convenience (ATM, baggage carts, etc. )
8. Navigability (ease of finding way, info screens, etc.)
9. Inspection (ID inspection before security checking)
10. Immigration (customs, etc.)
11. Cleanliness



# Factor Analysis Result

## Uniquenesses:

Ground.transportation.to.from.airport	0.876	Parking.facilities	0.041
Parking.facilities..value.for.money.	0.121	Availability.of.baggage.carts	0.578
Efficiency.of.check.in.staff	0.261	Check.in.wait.time	0.044
Courtesy.of.of.check.in.staff	0.108	wait.time.at.passport.inspection	0.005
Courtesy.of.inspection.staff	0.270	Courtesy.of.security.staff	0.450
Thoroughness.of.security.inspection	0.221	wait.time.of.security.inspection	0.296
Feeling.of.safety.and.security	0.153	Ease.of.finding.your.way.through.the.airport	0.378
Flight.information.screens	0.625	walking.distance.inside.terminal	0.322
Ease.of.making.connections	0.815	Courtesy.of.airport.staff	0.750
Restaurants	0.005	Restaurants..value.for.money.	0.267
Availability.of.banks.ATM.money.changing	0.519	shopping.facilities	0.082
shopping.facilities..value.for.money.	0.171	Internet.access	0.749
Business.executive.lounges	0.412	Availability.of.washrooms	0.378
Cleanliness.of.washrooms	0.139	Comfort.of.waiting.gate.areas	0.512
Cleanliness.of.airport.terminal	0.396	Ambience.of.airport	0.164
Arrivals.passport.and.visa.inspection	0.094	speed.of.baggage.delivery	0.807
Customs.inspection	0.415		

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8	Factor9
ss loadings	3.079	2.626	1.894	1.892	1.859	1.831	1.827	1.804	1.691
Proportion Var	0.093	0.080	0.057	0.057	0.056	0.055	0.055	0.055	0.051
Cumulative Var	0.093	0.173	0.230	0.288	0.344	0.399	0.455	0.509	0.561
	Factor10	Factor11							
ss loadings	1.581	1.491							
Proportion Var	0.048	0.045							
Cumulative Var	0.609	0.654							

# Regression Results

## Regression with 33 Features

```
Coefficients:
(Intercept) 1.050607 0.189883 5.533 6.41e-08 ***
x_smallGround.transportation.to.from.airport 0.001773 0.012133 0.146 0.88393
x_smallParking.facilities -0.009425 0.033685 -0.280 0.77981
x_smallParking.facilities..value.for.money. 0.002348 0.035492 0.066 0.94729
x_smallAvailability.of.baggage.carts 0.006142 0.016112 0.381 0.70331
x_smallEfficiency.of.check.in.staff 0.024692 0.030107 0.820 0.41272
x_smallCheck.in.wait.time 0.004094 0.041544 0.099 0.92156
x_smallCourtesy.of.of.check.in.staff -0.009341 0.038729 -0.241 0.80956
x_smallWait.time.at.passport.inspection -0.024326 0.026743 -0.910 0.36367
x_smallCourtesy.of.inspection.staff 0.040320 0.028927 1.394 0.16430
x_smallCourtesy.of.security.staff 0.006820 0.027554 0.248 0.80467
x_smallThoroughness.of.security.inspection -0.016820 0.038378 -0.438 0.66147
x_smallWait.time.of.security.inspection 0.056516 0.036537 1.547 0.12286
x_smallFeeling.of.safety.and.security -0.003639 0.043243 -0.084 0.93298
x_smallEase.of.finding.your.way.through.the.airport 0.006658 0.038965 0.171 0.86443
x_smallFlight.information.screens -0.003050 0.024301 -0.126 0.90019
x_smallWalking.distance.inside.terminal 0.062079 0.038709 1.604 0.10972
x_smallEase.of.making.connections 0.024993 0.012767 1.958 0.05112
x_smallCourtesy.of.airport.staff -0.009629 0.015529 -0.620 0.53566
x_smallRestaurants 0.010541 0.025428 0.415 0.67875
x_smallRestaurants..value.for.money. -0.013690 0.026472 -0.517 0.60539
x_smallAvailability.of.banks.ATM.money.changing -0.023630 0.018824 -1.255 0.21024
x_smallShopping.facilities 0.025351 0.025235 1.005 0.31582
x_smallShopping.facilities..value.for.money. -0.007908 0.028848 -0.274 0.78416
x_smallInternet.access 0.013696 0.014092 0.972 0.33179
x_smallBusiness.executive.lounges -0.010975 0.020982 -0.523 0.60128
x_smallAvailability.of.washrooms -0.002423 0.028704 -0.084 0.93278
x_smallCleanliness.of.washrooms -0.012452 0.027090 -0.460 0.64607
x_smallComfort.of.waiting.gate.areas 0.102725 0.032751 3.137 0.00186 **
x_smallCleanliness.of.airport.terminal 0.100394 0.047911 2.095 0.03689 *
x_smallAmbience.of.airport 0.446561 0.050837 8.784 < 2e-16 ***
x_smallArrivals.passport.and.visa.inspection -0.118101 0.028021 -4.215 3.23e-05 ***
x_smallSpeed.of.baggage.delivery 0.002710 0.013558 0.200 0.84168
x_smallCustoms.inspection 0.039604 0.033443 1.184 0.23718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4691 on 331 degrees of freedom
Multiple R-squared:  0.5801,    Adjusted R-squared:  0.5383
F-statistic: 13.86 on 33 and 331 DF,  p-value: < 2.2e-16
```

- Overall model is significant, only 5 out of 33 features are significant.

## Regression with 11 Factors

```
Coefficients:
(Intercept) 4.43014 0.02447 181.014 < 2e-16 ***
fx_smallsecurity 0.15708 0.02328 6.747 6.20e-11 ***
fx_smallcheck in 0.08060 0.02402 3.356 0.000878 ***
fx_smallshopping 0.04658 0.02334 1.996 0.046731 *
fx_smallwashroom 0.11758 0.02291 5.133 4.71e-07 ***
fx_smallParking -0.01129 0.02403 -0.470 0.638851
fx_smallRestaurants 0.05689 0.02438 2.333 0.020205 *
fx_smallConvenience 0.03163 0.02060 1.535 0.125607
fx_smallNavigability 0.14726 0.02174 6.772 5.31e-11 ***
fx_smallID Inspection 0.03556 0.02437 1.459 0.145470
fx_smallImmigration -0.11726 0.02345 -5.000 9.05e-07 ***
fx_smallCleanliness 0.38792 0.02226 17.423 < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4676 on 353 degrees of freedom
Multiple R-squared:  0.5551,    Adjusted R-squared:  0.5412
F-statistic: 40.04 on 11 and 353 DF,  p-value: < 2.2e-16
```

- Overall model is significant, 8 out of 11 factors are significant.

# Regression with Factor Scores

## ➤ TOP 6 significant factors:

1) Cleanliness, 2) Security Process,  
3) Navigability, 4) Washroom,  
5) Immigration, 6) Check in process

## ➤ Insignificant factors:

Parking, Convenience, ID Inspection

### Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	4.43014	0.02447	181.014	< 2e-16	***
fx_smallSecurity	0.15708	0.02328	6.747	6.20e-11	***
fx_smallcheck in	0.08060	0.02402	3.356	0.000878	***
fx_smallshopping	0.04658	0.02334	1.996	0.046731	*
fx_smallwashroom	0.11758	0.02291	5.133	4.71e-07	***
fx_smallParking	-0.01129	0.02403	-0.470	0.638851	
fx_smallRestaurants	0.05689	0.02438	2.333	0.020205	*
fx_smallConvenience	0.03163	0.02060	1.535	0.125607	
fx_smallNavigability	0.14726	0.02174	6.772	5.31e-11	***
fx_smallID Inspection	0.03556	0.02437	1.459	0.145470	
fx_smallImmigration	-0.11726	0.02345	-5.000	9.05e-07	***
fx_smallcleanliness	0.38792	0.02226	17.423	< 2e-16	***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4676 on 353 degrees of freedom  
Multiple R-squared: 0.5551, Adjusted R-squared: 0.5412  
F-statistic: 40.04 on 11 and 353 DF, p-value: < 2.2e-16

# Cluster Analysis Result

➤ Total 6 clusters were formed

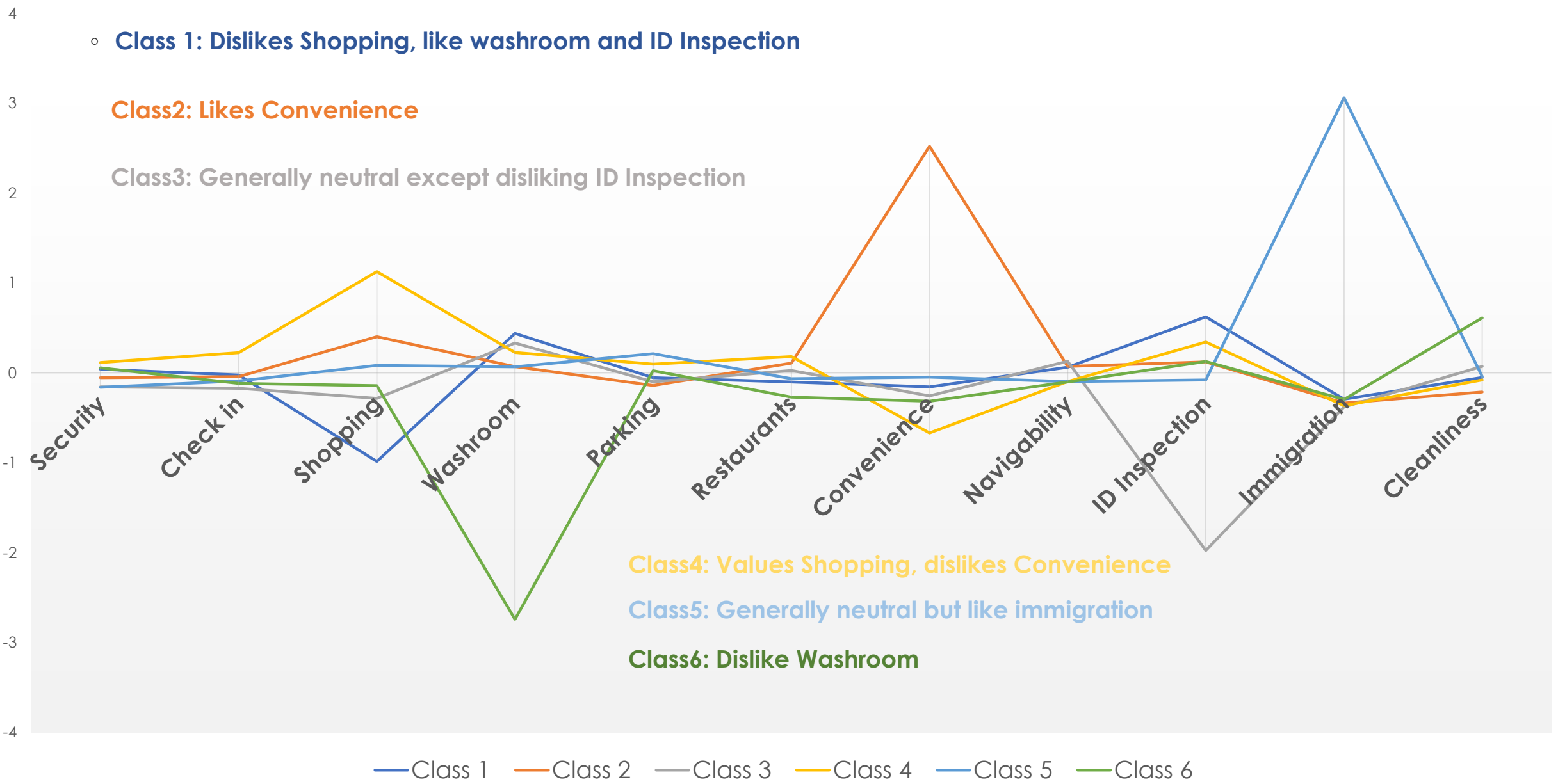
Clusters	Security	Check in	Shopping	Washroom	Parking	Restaurants	Convenience	Navigability	ID Inspection	Immigration	Cleanliness	N of Clusters	% of Total
Class 1	0.039	-0.026	-0.988	0.436	-0.056	-0.104	-0.158	0.062	0.621	-0.294	-0.053	107	29%
Class 2	-0.056	-0.045	0.400	0.068	-0.143	0.106	2.520	0.070	0.121	-0.339	-0.214	42	12%
Class 3	-0.159	-0.173	-0.285	0.330	-0.101	0.024	-0.259	0.126	-1.979	-0.381	0.070	53	15%
Class 4	0.113	0.223	1.126	0.225	0.096	0.179	-0.670	-0.099	0.341	-0.367	-0.081	94	26%
Class 5	-0.162	-0.091	0.082	0.066	0.212	-0.067	-0.049	-0.099	-0.080	3.060	-0.042	36	10%
Class 6	0.054	-0.119	-0.144	-2.745	0.022	-0.271	-0.317	-0.103	0.125	-0.296	0.609	33	9%
% of Positive	50%	17%	50%	83%	50%	50%	17%	50%	67%	17%	33%		
% of Negative	50%	83%	50%	17%	50%	50%	83%	50%	33%	83%	67%		

Only cluster 2 likes Convenience

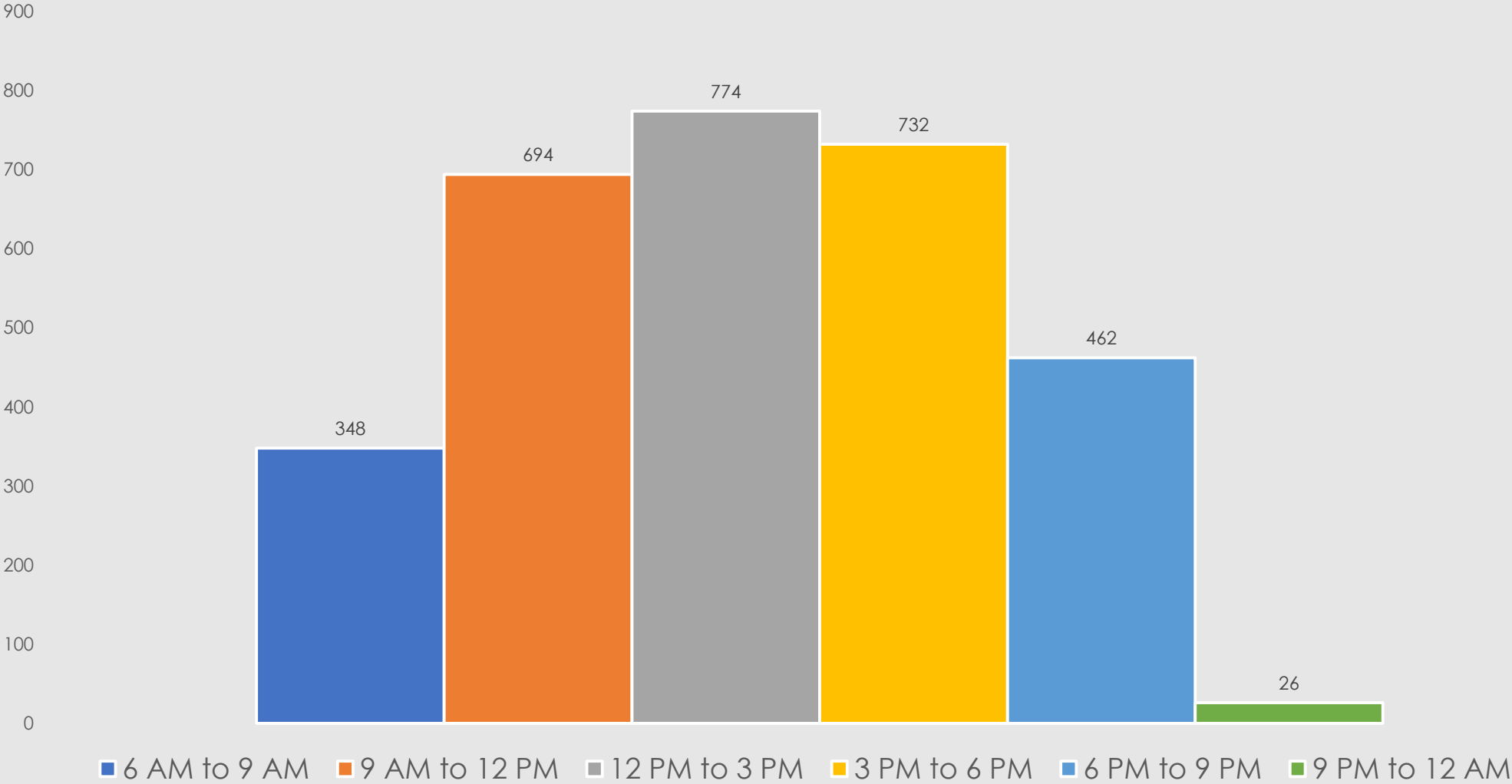
Washroom is overall good,  
but cluster 6 dislikes it.

Only cluster 5 likes immigration

# Factor Scores across Clusters



# Airport Traffic



# Cluster Analysis Result

## ➤ Overall Satisfaction

	2	3	4	5	N of Clusters	% of Total
Class 1	0	9	41	57	107	29%
Class 2	0	5	10	27	42	12%
Class 3	0	2	24	27	53	15%
Class 4	0	6	32	56	94	26%
Class 5	2	9	13	12	36	10%
Class 6	0	5	10	18	33	9%
	2	3	4	5	N of Clusters	% of Total
Class 1	0%	8%	38%	53%	107	29%
Class 2	0%	12%	24%	64%	42	12%
Class 3	0%	4%	45%	51%	53	15%
Class 4	0%	6%	34%	60%	94	26%
Class 5	6%	25%	36%	33%	36	10%
Class 6	0%	15%	30%	55%	33	9%

Class 5 has most even satisfaction distribution.

Class 2, who is the only one like our "Convenience", has highest overall satisfaction.

# Cluster Analysis Result

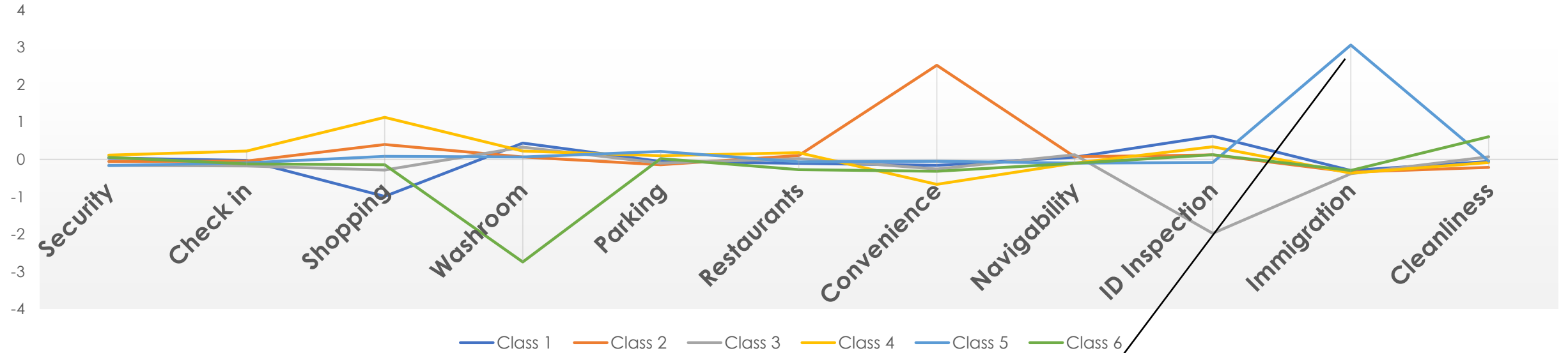
## ➤ Flight Hour

	6AM-9AM	9AM-12AM	12PM-3PM	3PM-6PM	6PM-9PM	N of Clusters	% of Total
Class 1	19	18	34	22	14	107	29%
Class 2	8	14	9	5	6	42	12%
Class 3	7	16	13	12	5	53	15%
Class 4	10	25	24	18	17	94	26%
Class 5	0	8	2	6	20	36	10%
Class 6	6	10	4	9	4	33	9%
	6AM-9AM	9AM-12AM	12PM-3PM	3PM-6PM	6PM-9PM	N of Clusters	% of Total
Class 1	18%	17%	32%	21%	13%	107	29%
Class 2	19%	33%	21%	12%	14%	42	12%
Class 3	13%	30%	25%	23%	9%	53	15%
Class 4	11%	27%	26%	19%	18%	94	26%
Class 5	0%	22%	6%	17%	56%	36	10%
Class 6	18%	30%	12%	27%	12%	33	9%

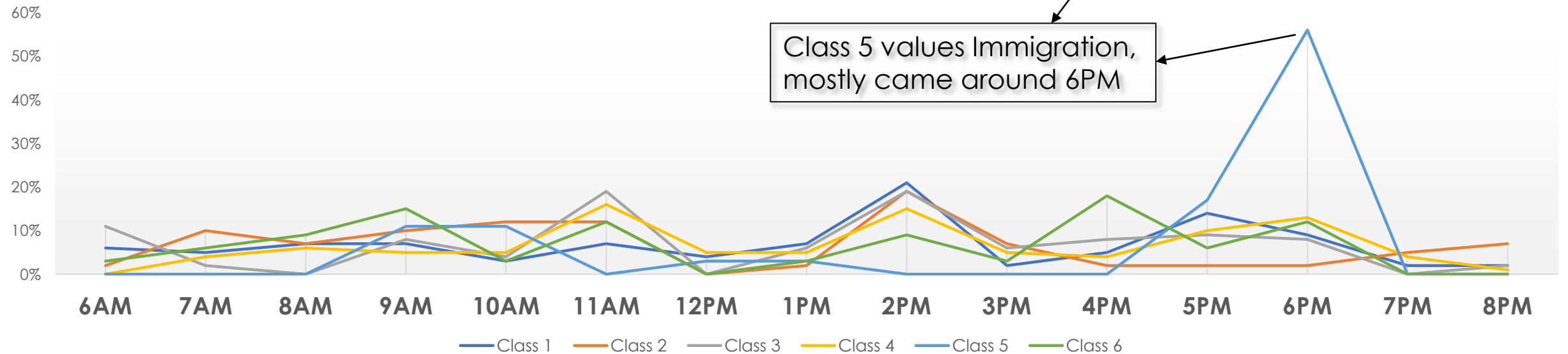
Class 5, who like our "immigration", 56% arrived/departure at airport at around 6pm.



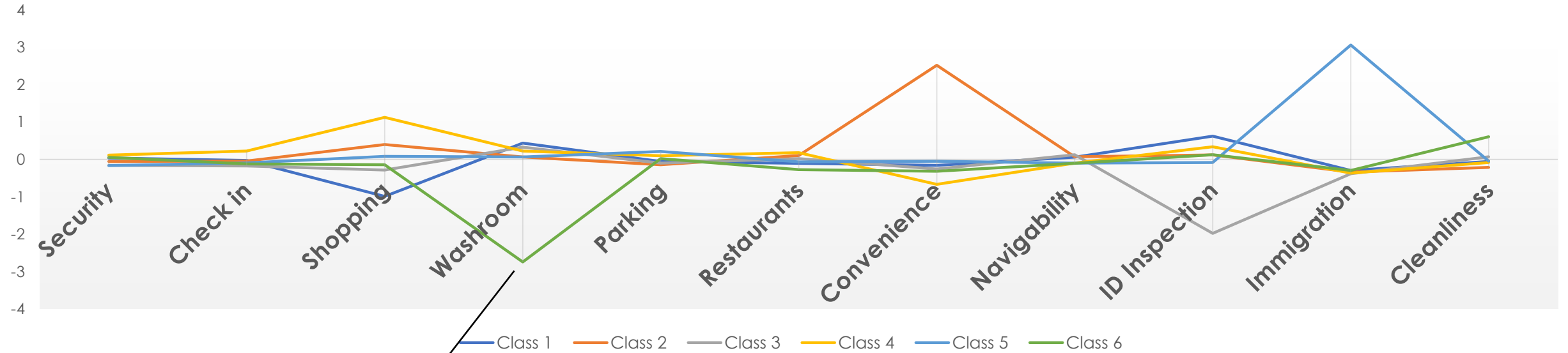
### Factor Scores across Clusters



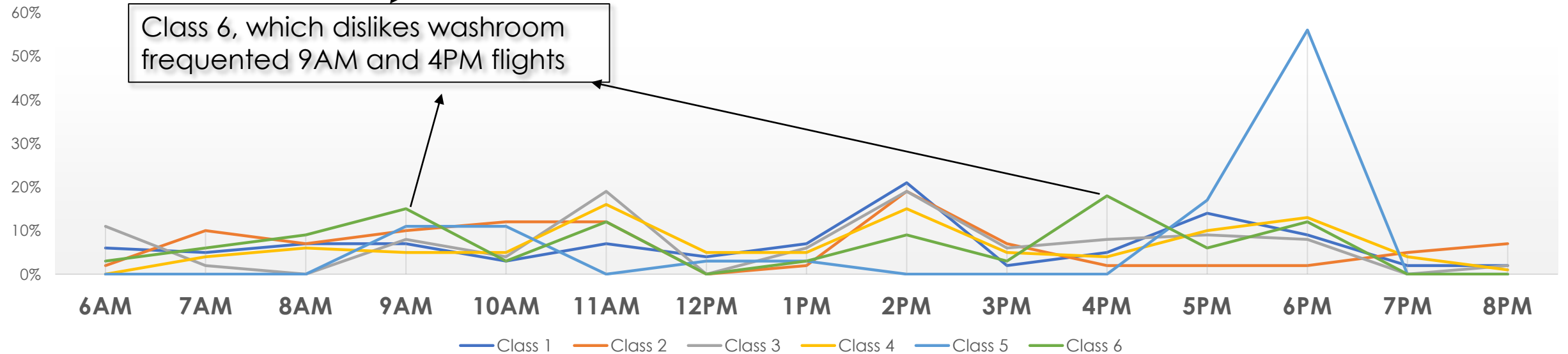
### Clusters and Flight Hour



### Factor Scores across Clusters

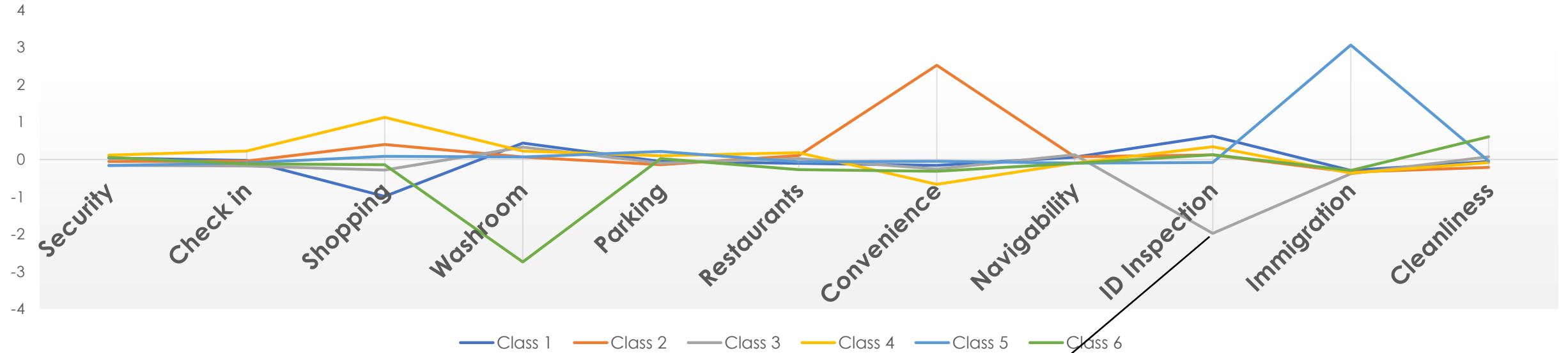


### Clusters and Flight Hour

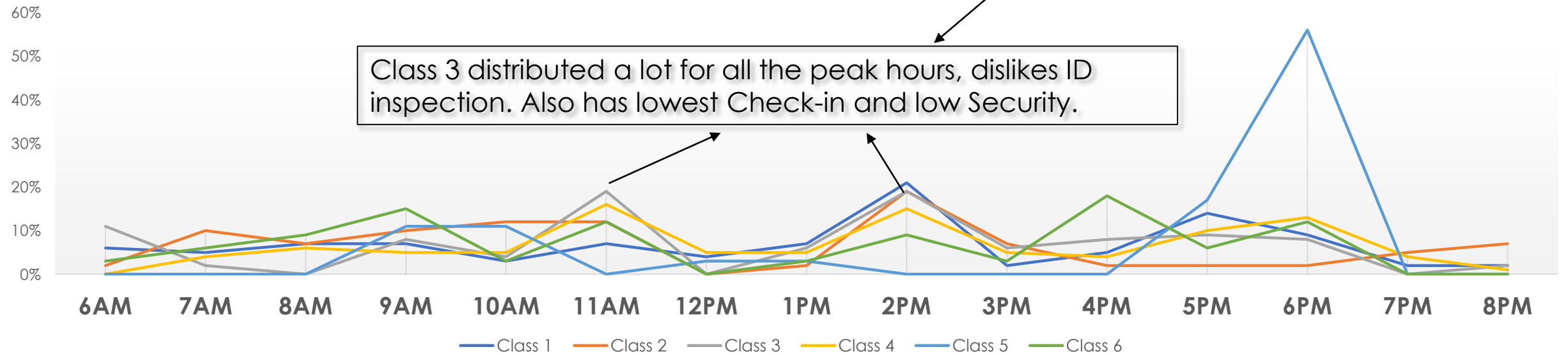


Class 6, which dislikes washroom  
frequented 9AM and 4PM flights

### Factor Scores across Clusters



### Clusters and Flight Hour



# Managerial Implications

- Keep improving significant factors, such as cleanliness, security checking process, and navigability (info screens, etc.)
- It is necessary to improve “Convenience” and “Immigration” (overall unsatisfied factors)
- We can use time breakdowns to judge how shifts perform
- Work shifts of “Immigration” (customs, arrival passport inspection, etc.) at around 6pm are doing well (Class 5)
- Check with washroom at around 9AM and 4PM (Class 6)

***Question?***



# THANK YOU!

TEAM B-03