PROJECT MANAGEMENT
CENTER FOR EXCELLENCE
A.J. CLARK SCHOOL OF ENGINEERING
Civil & Environmental Engineering Department

DETERMINING FACTORS AFFECTING PUBLIC PRIVATE PARTNERSHIP (P3) ACCEPTANCE

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Presentation Outline

- Introduction
- Research Motivation
- Principal Component Analysis
- Sample Example
- Case Study
- Results and Conclusion

PUBLIC PRIVATE PARTNERSHIPs (PPPs)

What is a Public Private Partnership (PPP)?

- A contractual agreement between a public sector agency (federal, state, or local) and a private entity. (NCPPP)
- Works together on a platform to provide public service and goods.
- Improves the schedule, quality, and risk of a project.

Public Private Partnership

- PPPs are widely accepted in countries like Canada, United Kingdom, and Australia.
- In the US, only 33 states, District of Columbia and One US territory (Puerto Rico) has PPP legislation.
- Several others are considering to have PPP enabling legislation

PPP Types

- Operation-Maintenance (OM)
- Design-Build (DB)
- Design-Build-Operate (DBO)
- Design-Build-Finance-Operate-Maintain (DBFOM)
- Build-Operate-Transfer (BOT)
- Build-Own-Operate (BOO)

Risk Allocation in PPPs

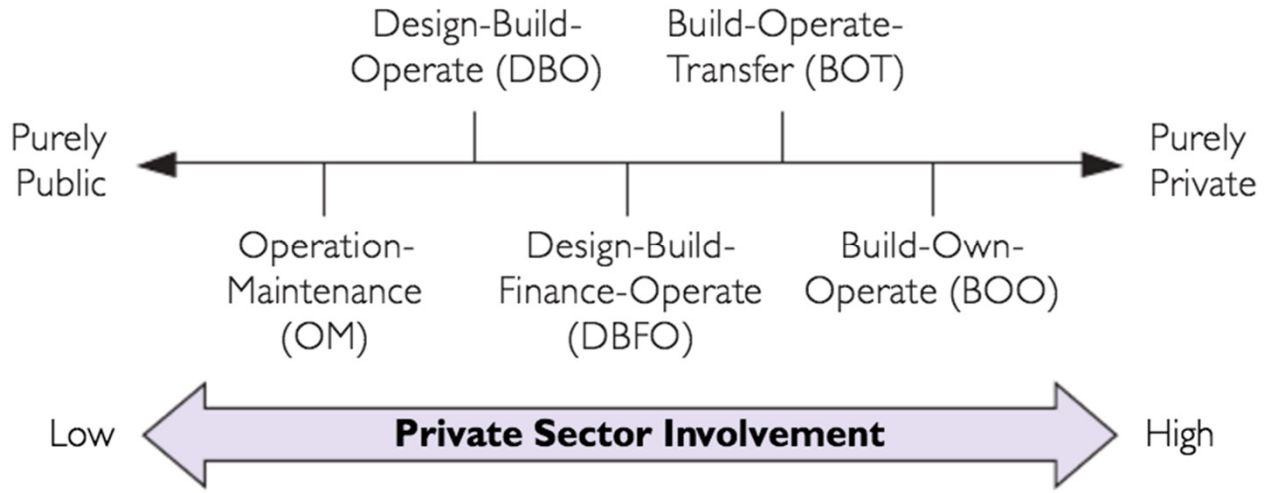


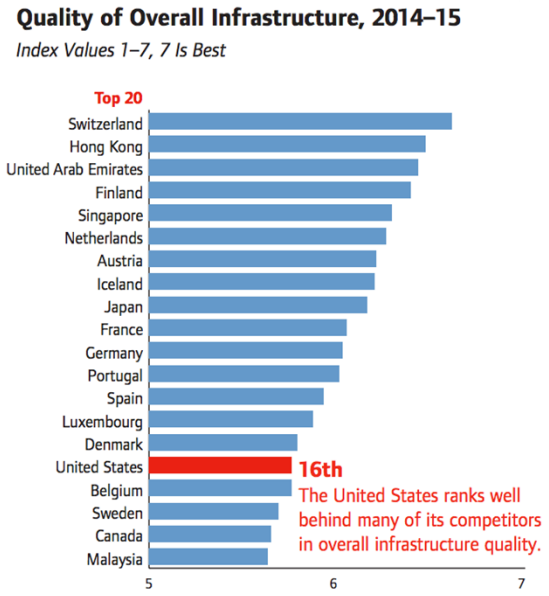
Figure 1: Continuum of Types of PPP

Source: Kwak et. al., 2009

Research Motivation

Infrastructure Quality

- United States ranks 16th in the world for quality of infrastructure.
- Government spends more on health care, social security and defense.



Source: World Economic Forum, "Global Competitiveness Report 2014-2015."

Infrastructure Grade

- Report Card for America's Infrastructure: D+ Grade and for highways: D Grade
- 42% of urban highways are congested.
- 1 in 4 bridges in the national highway system is structurally deficient.
- $3.6 trillion estimated investment needed by 2020.

Source: Multiple Websites Listed in Reference Section

The thought that triggered this research

- Some states that that have demographic similarities have accepted PPPs.
  - The states with higher employment potential
  - Highly populated
- People in these states tend to accept PPPs

List of Available Demographic Factors

- Congestion
- Vehicles Miles Travelled
- Per Capita Income
- Gender Distribution
- Population Density
- Average Education
- Traffic Count
- Travel Time to Work
- Cost of Living

Methodology – Principal Component Analysis (PCA)

- PCA is a data reduction technique

Used in Sociology

Used in Image Processing

What is Principal Component Analysis (PCA)

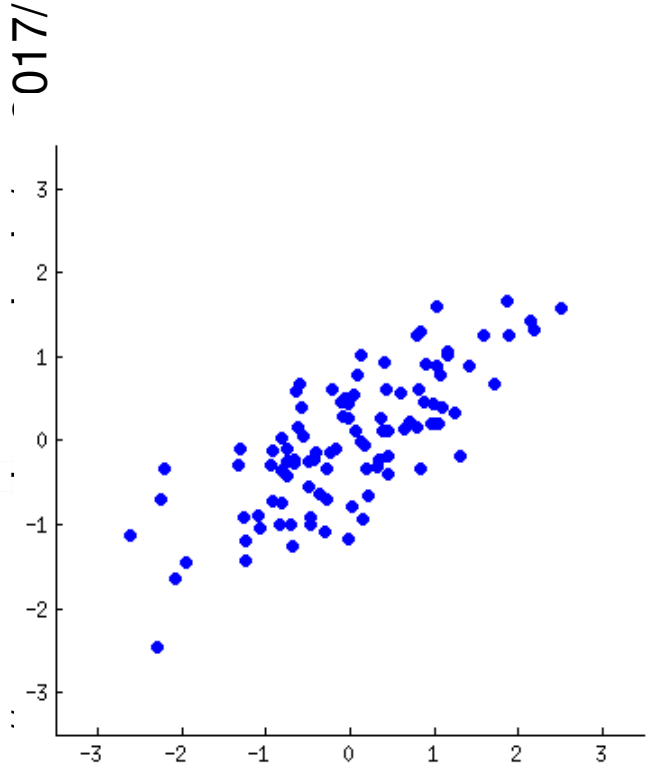
- Principal Component Analysis (PCA) is a data reduction technique.
  - Allows for summarizing things/facts/processes (variable of interest) with lesser number of characteristics

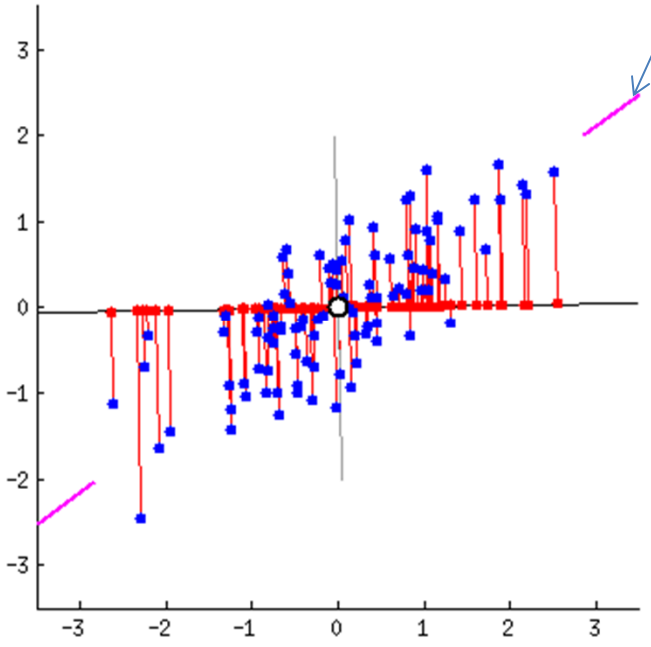
    (For example: 47 characteristics can be represented by just 3 characteristics)
  - Enables representing the combining several characteristics into fewer characteristics

    (For example: the 3 characteristics are combination of 39 characteristics)

What is Principal Component Analysis (PCA)

Maximum Variance and Minimum Error





Represents new feature (variable) that is represented by the two variables

Image Source: https://stats.stackexchange.com/questions/2691/making-sense-of-principal-component-analysis-eigenvectors-eigenvalues

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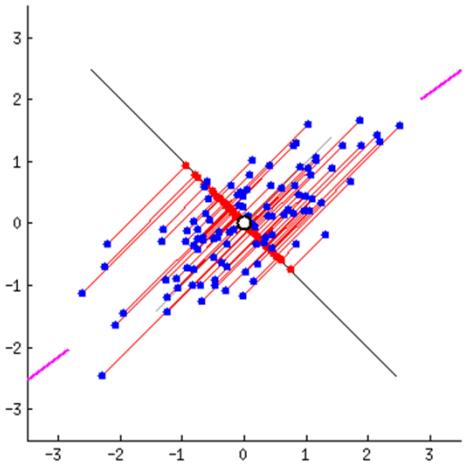
What is Principal Component Analysis (PCA)

- Imagine the red lines a springs



- PCA enables us to identify all such new features (variables) that will enable covering maximum variance and reduce the errors to minimum

Image Source: https://stats.stackexchange.com/questions/2691/making-sense-of-principal-component-analysis-eigenvectors-eigenvalues

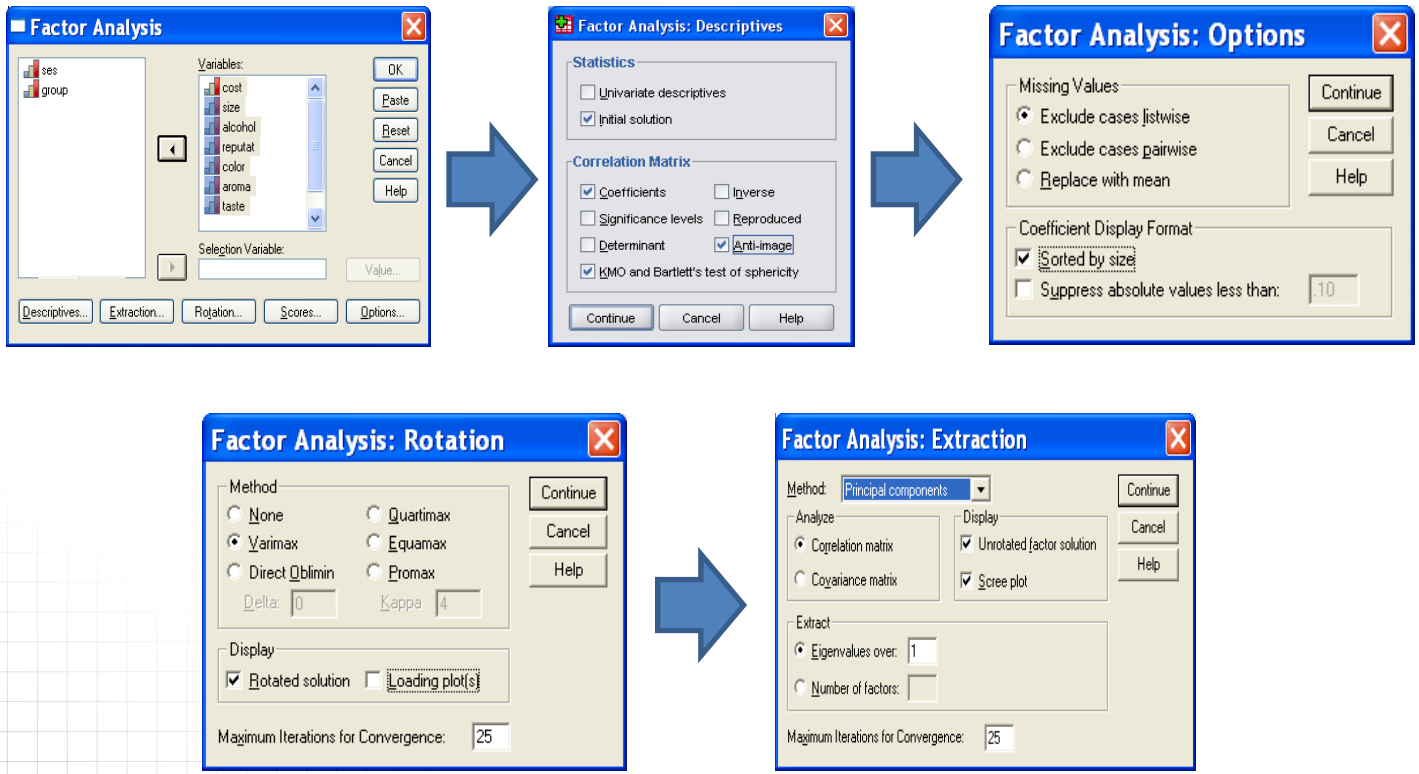
An Example on PCA Application

Example – Lets analyze Beer

- Consumers rating for seven different characteristics of a beer:
  - low **COST**
  - high **SIZE** of bottle
  - high **ALCOHOL** content
  - **REPUTATION** of Brand
  - **COLOR**
  - **AROMA**
  - **TASTE**

Source: Wuensch, 2012

SPSS Steps for PCA



Source: Wuensch, 2012

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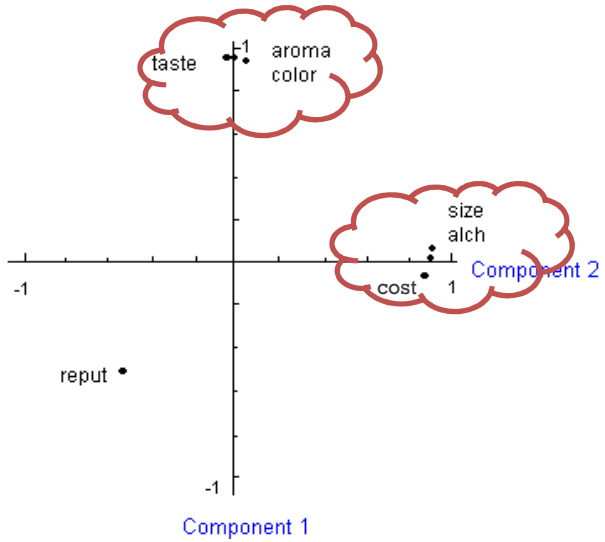
Example Result

	Component	
	1	2
TASTE	.960	-.028
AROMA	.958	1.E-02
COLOR	.952	6.E-02
SIZE	7.E-02	.947
ALCOHOL	2.E-02	.942
COST	-.061	.916
REPUTAT	-.512	-.533

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalizatic

Rotated Component Matrix



Grouped Variables

Source: Wuensch, 2012

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Naming Components

- Component 1
  - Higher factor loading value for TASTE, AROMA, and COLOR"
  - This component can be recognized as **AESTHETIC QUALITY** of beer.
- Component 2
  - Higher factor loading value for large SIZE, high ALCOHOL content, and low COST.
  - The component can be recognized as a **CHEAP DRINK**.

Source: Wuensch, 2012

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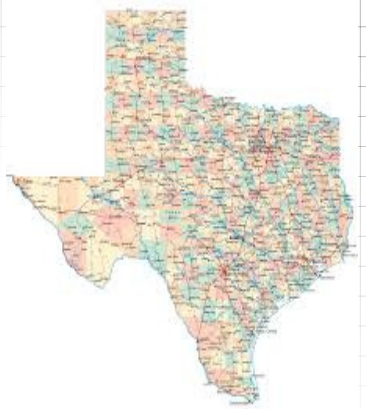
Using PCA for Demographic Factors Influencing PPPs

States Selection

- 3 most populated US States:
  - California
  - Texas
  - Florida
- Total 29 cities of 3 States considered as MSA (Metropolitan Statistical Area).

California

- State of California is known for extensive highway networks.
- Los Angeles and San Francisco are facing congestion issues.
- Los Angeles comes in world's top 10 traffic congestion cities.
- According to Forbes, LA takes 41% extra travel time.



Texas

- Facing issues due to long commutes.
- Austin ranks 10th in nation for worst traffic congestion.
- Rapid growth in population affects the traffic condition significantly.

Florida

- 60% of population lives in only 5% of the state's region
- 7 cities from the state of Florida are facing major congestion challenges.
- South Florida ranks 11th in traffic congestion among 498 metro areas.

Variables Selection

- 9 Demographic variables of 23 cities:
    - daily **COST OF DELAY**,
    - daily **VEHICLE MILES TRAVELLED**,
    - per capita **INCOME**,
    - **GENDER** distribution,
    - population **DENSITY**,
    - average **EDUCATION**,
    - daily **TRAFFIC** count,
    - Average **TRAVEL TIME**, and
    - **COST** of **LIVING**

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Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**.604**
Bartlett's Test of Sphericity	Approx. Chi-Square	148.617
	df	36
	Sig.	.000

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Results

Total Variance Matrix

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.133	51.659	51.659	4.133	51.659	51.659	2.871	35.884	35.884
2	1.375	17.193	68.852	1.375	17.193	68.852	2.604	32.555	68.439
3	1.136	14.204	83.056	1.136	14.204	83.056	1.169	14.617	83.056
4	.738	9.221	92.276						
5	.266	3.322	95.599						
6	.211	2.640	98.238						
7	.073	.917	99.155						
8	.068	.845	100.000						

Extraction Method: Principal Component Analysis.

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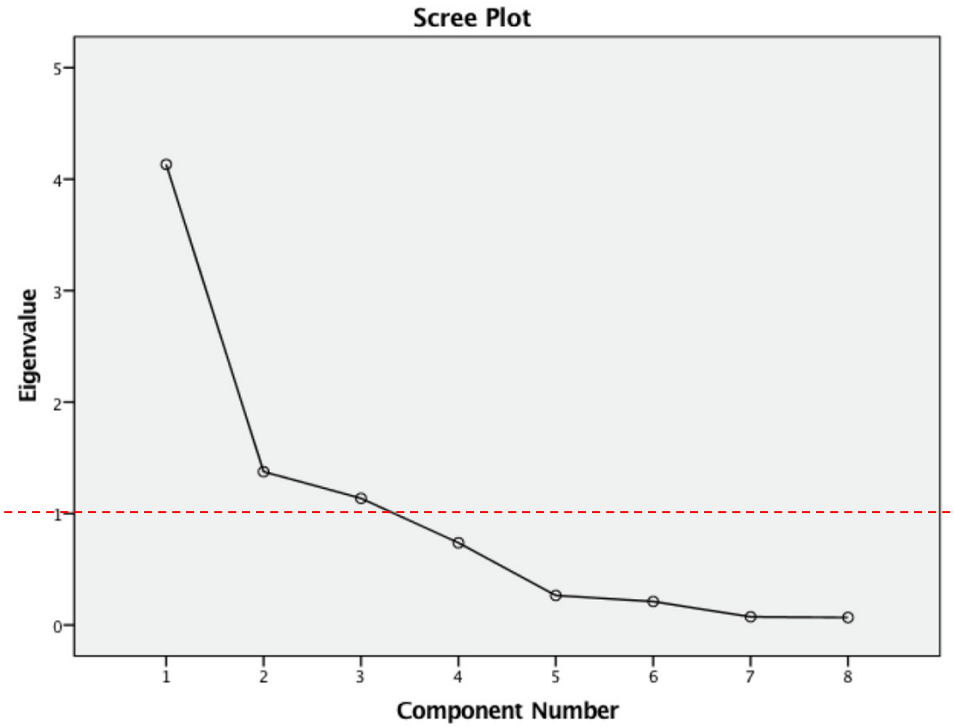
Results



Scree Plot Indicating Three Principal Components

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Results

Rotated Component Matrix Indicating Three Principal Components

Variables	1	2	3
Population Density	**0.905**		
Cost of Living (daily)	**0.823**	0.307	
Average Education	**0.770**	0.332	
Per Capita Income (per day)	**0.751**	0.499	
Traffic Count Daily		**0.901**	
Cost of Delay (daily)	0.384	**0.837**	
Average Travel Time (daily)		**0.794**	
Vehicle Miles Travelled (daily)			**0.984**

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Results

Communalities

Variables	Initial	Extraction
Congestion Cost	1.000	.902
Vehicle Miles Travelled	1.000	.937
Per Capita Income	1.000	.850
Travel Time to Work	1.000	.885
Cost of Living	1.000	.857
Average Education	1.000	.886
Traffic Count	1.000	.873
Population Density	1.000	.835
Gender Distribution	1.000	.731

Are the results valid?

- PCA is a large sample test!
- Desirable to get large samples
- Researchers have demonstrated that if the communalities are higher than 0.6 (MacCallum et al., 1999; Henson & Roberts, 2006) and if the average of communalities is greater than 0.7 (Field, 2009; Yong & Pearce, 2013)
  - PCA using relatively small sample size are acceptable; the results obtained from such analysis will be stable.

Interpreting the Results

- Component 1

Four variables per capita income (0.751), cost of living (0.823), average education (0.77), and population density (0.905) make first component.

Component named as REGIONAL DEVELOPMENT.

- Component 2

Cost of delay (0.837), average travel time (0.794) and traffic count daily (0.901) make the second component.

Component named as CONGESTION in the region

Interpreting the Results

- Component 3

Daily Vehicle Miles Travelled (0.984) makes the third component.

Component is VEHICLE MILES TRAVELLED

Conclusion, Implications and Path Ahead

- **Three factors** tend to directly influence people's acceptance on PPPs in California, Texas and Florida.
- Agencies can conduct **similar research with more data and more number of variables**.
- Agencies can **conduct micro level surveys** (by administering questionnaire survey to end-users of the region)

Conclusion, Implications and Path Ahead

- Conducting micro level questionnaire surveys could help identify **other factors**
- This research can be extended to **other states** that do not plan to adopt PPPs
- Results can be used by **outreach programs**.
- Government and infrastructure agencies can take steps to **ensure PPP acceptance and success**

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Thank you for your undivided attention

Questions?

http://pmsymposium.umd.edu/pm2017/

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