Multivariate Analysis of Processes
Data from Senior alert

Background: Advanced Ceramics

Ceramic bearings – Si₃N₄
This presentation exemplifies how a process might

- Analyze "all" data simultaneously
- Get more complete and earlier special cause detection
- Find outliers
- Find correlations
- Find trends

So, here is how you reduce avoidable readmissions

From Bob Lloyd IHI

Give all patients and families a booklet that describes how to prevent readmissions

Reduce Readmissions and Harm

Is life this simple?
The messiness of life looks more like this...

In this case, there are numerous direct and indirect effects between the independent variables and the dependent variable. For example, X1 and X4 both have direct effects on Y plus there is an indirect effect due to the interaction of X1 and X4 conjointly on Y.

From Bob Lloyd IHI

\[ R = \text{residuals or error terms representing the effects of variables not included in the model.} \]

PRESENTATION PARTS

DATA

ANALYSIS OVER TIME

COMPARATIVE ANALYSIS
Process data matrix:

Observations

Variables

The preventive care process – Senior alert

1. Care contact
2. Risk assessment
3. Team based analysis of risks
4. Planning and execution of preventive action plans
5. Evaluation
6. Leaving the caregiver
DATA

VARIABLES
1. RISK ASSESSMENTS (abbr Ra)
2. RA WITH RISK
3. RA PER PERSON
4. TEAMBASED INVESTIGATIONS ON RISKS
5. PROPORTION ROAD
6. PROPOTION Nikola
7. PROPORTION WITH PLANNED PREVENTIVE INTERVENTION (abbr PI)
8. PROPORTION WITH EXECUTED PI
9. NUMBER OF PLANNED PI:S PER RA
10. NUMBER OF EXECUTED PI:S PER RA
11. EVALUATIONS ON RISKS
12. BMI
13. AGE
14. PROPORTION OF WOMEN
15. DAYS TO EVALUATION
16. PROPORTION WEIGHT LOSS >5% AT EVALUATION

PRESENTATION PARTS

DATA

ANALYSIS OVER TIME

COMPARATIVE ANALYSIS
**Control Chart Rules for Detecting Special Causes**

From Bob Lloyd IHI

1. A single point outside the control limits

2. Eight or more consecutive points above or below the centerline

3. Six consecutive points increasing (trend up) or decreasing (trend down)

4. Two our of three consecutive points near a control limit (outer one-third)

5. Fifteen consecutive points close to the centerline (inner one-third)

---

**Analysis over Time**

**More Complete Special Cause Detection When All Variables Analyzed Together**

- Variable 1: Outliers
- Variable 2: Outliers

---

The Microsystem Festival Feb 24-27 2015
punkt.jikps/microsystemfeolkv
Observations: Months

Variables

Analysis over time

Model method: Principal Component Analysis (PCA)

\[ X = T \times P' + E \]

Scores  Loadings  Residuals

Principal components
ANALYSIS OVER TIME

MODEL METHOD: PRINCIPAL COMPONENT ANALYSIS (PCA)

Principal components $t_1$, $t_2$

MODEL OVERVIEW (PCA)
Score plot and contribution plot

Variables contributing most to deviation

MSPC charts show special causes (trends)

\( t_1 \) increases systematically over time

\( t_2 \) increases the last few months
ANALYSIS OVER TIME

MSPC CHARTS FOR EARLIER SPECIAL CAUSE DETECTION

Variable 1

10 20 30 40

Time

Variable 2

-4 -3 -2 -1 0 1 2 3 4

-4 -3 -2 -1 0 1 2 3 4

Time

2 OUTLIERS

ANALYSIS OVER TIME

LOADING PLOT EXPLAINS MSPC CHART

Variables that increase last few months

Variables that decrease over time

Variables that increase over time

Variables that decrease last few months
**ANALYSIS OVER TIME**

**LOADING PLOT SHOWS CORRELATION PATTERN**

The loading plot shows the correlation pattern over time. Correlated variables are indicated with a blue circle, and negatively correlated variables are indicated with a green circle. The plot uses color coding according to model terms.

**PRESENTATION PARTS**

1. **DATA**
2. **ANALYSIS OVER TIME**
3. **COMPARATIVE ANALYSIS**
COMPARATIVE ANALYSIS

OBSERVATIONS: MUNICIPALITIES

VARIABLES

MUNICIPALITY

X

Y

SCORE PLOT FINDS OUTLIERS AND CLUSTERS
This presentation has exemplified how a process might

- Analyze "all" data simultaneously
- Get more complete and earlier special cause detection
- Find outliers
- Find correlations
- Find trends
Hot topic: Megavariate Analysis

• "Very many" variables
• Process has logical steps or blocks
• Hierarchical model:
  – PCA/PLS on each block and combined into Top model

Twitter: @dennisnordvallQ
– Megavariate Analysis and Process Improvement