le cnam

Importance of factors contributing to work-related stress: comparison of four metrics

Mounia N. Hocine, Natalia Feropontova, Ndèye Niang, Karim Aït-Bouziad, Gilbert Saporta

Conservatoire national des arts et métiers, Paris, France

9th June 2017

Outline

- Background – Aim
- Study data on stress and stressors
- Four metrics to rank stressors
- Results
- Conclusion

Background

- Stress: a major public health issue

➔ has negative effects on both physical and psychological health

➔ is an inevitable part of organizational life

The aim: Reduce work-related stress level

➔ Decision makers would like to be provided with statistical tools that can help them identify risk factors requiring a priority action

Data collection

- Provided by Stimulus (expert in occupational health & wellbeing) → 10 000 anonymous employees randomly drawn from different companies.

- Tools:
  - 1st questionnaire on work-related stress
  - 2nd questionnaire on job characteristics

→ both administrated to employees during their routine visit in preventive medicine service.

Stress measurement

- 1st questionnaire: 25 items to measure individual psychological stress at work
  → 8-point Likert scale.

- Example:

  "I'm confused and I lack focus and concentration" ,
  answer varies from 1 "not at all" to 8 "enormously"

Stress score = Σ responses $\in$ [25-200]

Study data

Psychosocial factors measurement

• 2nd questionnaire: 58 items to measure the impact of job characteristics (stressors) → 6-point Likert scale.

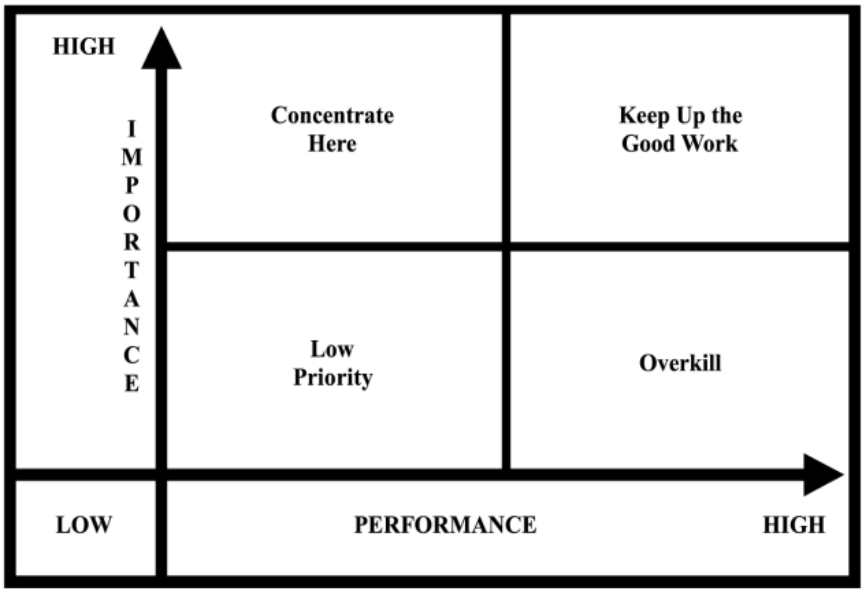
• Ex. 1: "My company does not care about employees well-being" answer varies from 0 "totally disagree" to 5 "totally agree"

➔ The 58 items are grouped by the experts into 5 blocks:

Context (14 items),
Job control (14 items),
Relationships (12 items),
Tasks (12 items)
Recognition (6 items).

Combined approach

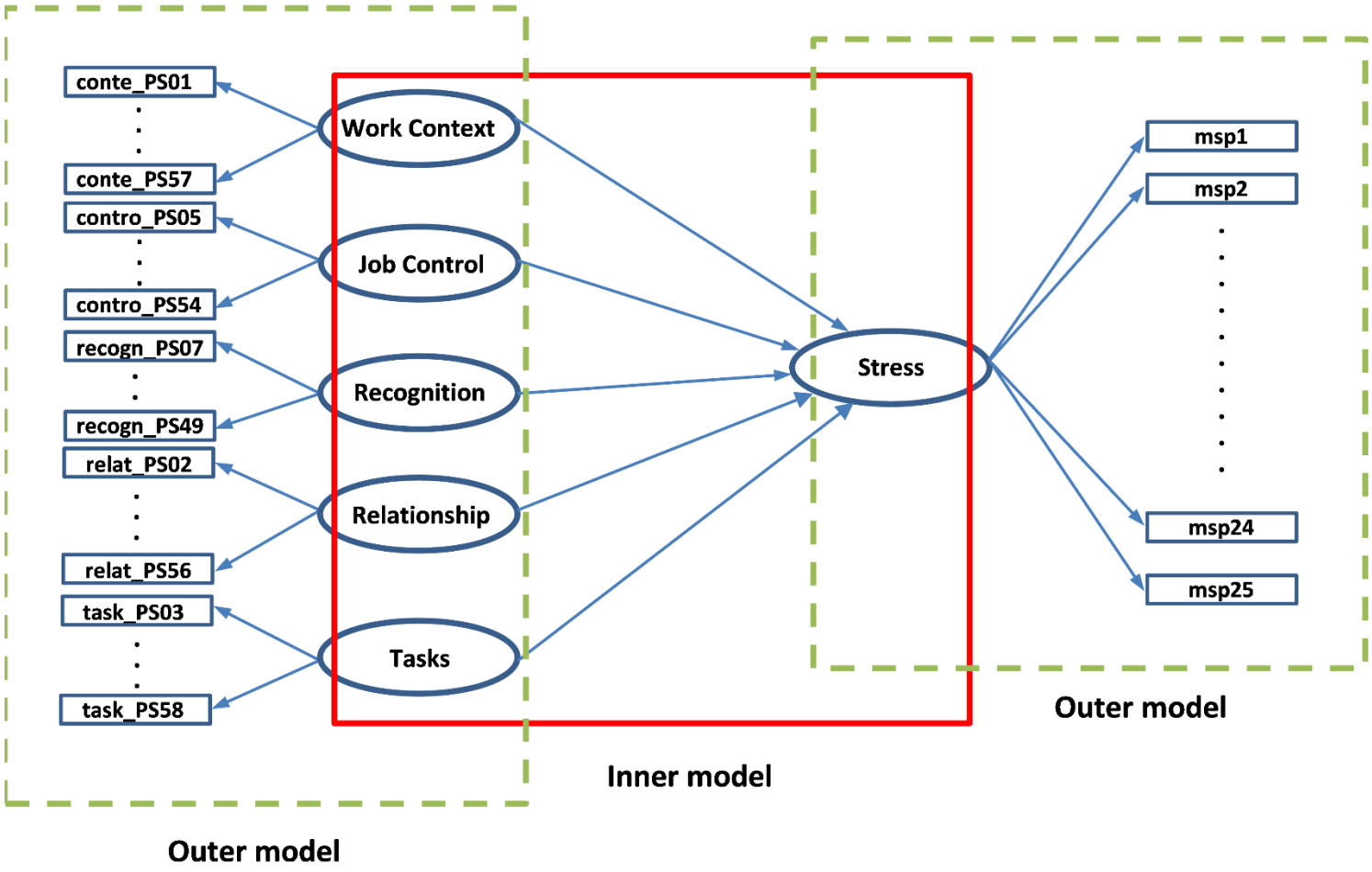
- We used Importance-Performance Analysis



- Importance: calculated using Structural Equation Modeling

Hocine, Aït Bouziad, Légeron, Dab, Saporta, ***Plos One 2016***

Step 1: Structural Equation Modeling



Conceptual model

Step 2: Importance-Performance Analysis

- Performance: measured as the score mean of 10 000 responses

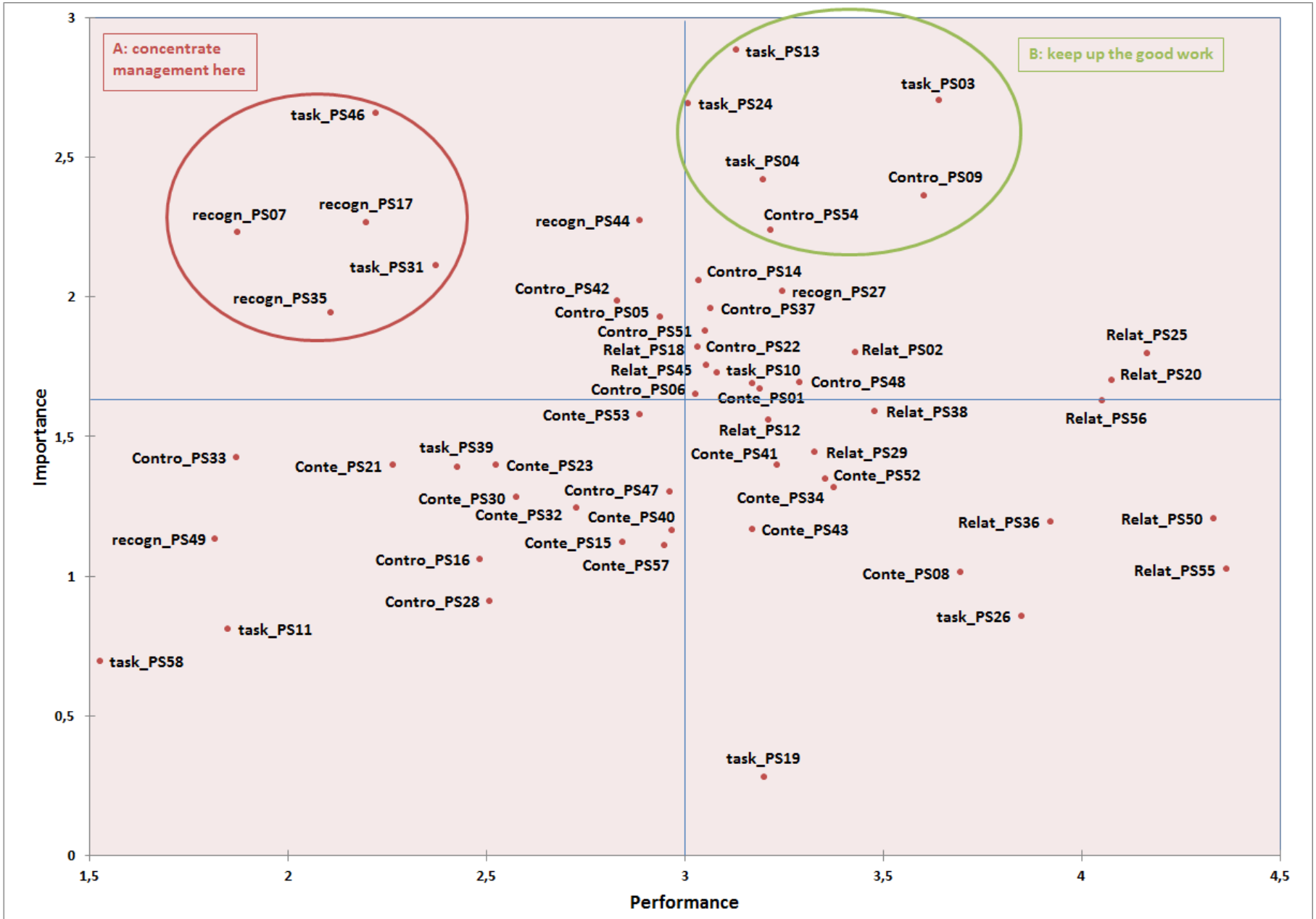
- Importance: calculated using the suggested formulae:

Importance (k^{th} item) = |Outer weight (k^{th} item in j^{th} block)| x

Path coefficient (j^{th} block, stress)

→ Graphical based decision making

Results


A: concentrate management here
B: keep up the good work
task_PS46
recogn_PS07
recogn_PS17
task_PS31
recogn_PS35
task_PS13
task_PS03
task_PS24
task_PS04
Contro_PS09
Contro_PS54
recogn_PS44
Contro_PS14
recogn_PS27
Contro_PS42
Contro_PS37
Contro_PS05
Contro_PS51
Relat_PS18
Contro_PS22
Relat_PS02
Relat_PS45
task_PS10
Contro_PS48
Contro_PS06
Conte_PS01
Relat_PS25
Relat_PS20
Relat_PS56
Conte_PS53
Relat_PS38
Relat_PS12
Contro_PS33
task_PS39
Conte_PS41
Relat_PS29
Conte_PS21
Conte_PS23
Conte_PS52
Contro_PS47
Conte_PS34
Conte_PS30
Conte_PS32
Conte_PS40
Relat_PS36
Relat_PS50
recogn_PS49
Conte_PS43
Conte_PS15
Contro_PS16
Conte_PS57
Conte_PS08
Relat_PS55
Contro_PS28
task_PS26
task_PS11
task_PS58
task_PS19
Importance
Performance
0
0,5
1
1,5
2
2,5
3
1,5
2
2,5
3
3,5
4
4,5

Limitations

- The suggested method (Plos One 2016) is not easy to use by decision makers

- Regression coefficients cannot be used directly to provide decision makers with ranked predictors ????

Alternative methods

We explore alternative metrics to calculate predictor's importance:

- Weifila method: variance decomposition
- Random forest
- Attributable Risk: logistic regression

1. Weifila "Weighted first last"

- A variance decomposition method used in linear regression context.

$$E(Y_1) \quad = \alpha + \beta_1 X_1 + \cdots + \beta_p X_p$$

- Assign to each predictor X_j a part of variance W(j) = weighted average between first and last allocation:

- Allocation "first": $First(j) = cov(y_1; X_j)$
- Allocation "last": $Last(j) = sr^2(j)$

$$\mathrm{L} = \sum_{\mathrm{j}} \mathrm{Last(j)}\,, \qquad \mathrm{F} = \sum_{\mathrm{j}} \mathrm{First(j)}$$

Justification intuitive de L et F ?

Decision rule

- $if\ L < R^2 < F\ then\ W(j) = Last(j)\left(\frac{F-R^2}{F-L}\right) + First(j)\left(\frac{R^2-L}{F-L}\right)$
- $if\ F < R^2 < L\ then\ W(j) = Last(j)\left(\frac{R^2-F}{L-F}\right) + First(j)\left(\frac{L-R^2}{L-F}\right)$

By construction: $\sum_j W(j) = R^2$

2. Random forest

- Random forests are a combination of tree predictors
- Each tree depends on the values of a random vector sampled independently with the same distribution for all trees in the forest
- We use bagging to generate random vectors…….

- Principe du calcul de l'importance?

3. Attributable risk

For each stressor, the association with “overstress”; a binary variable:

$$\text{Overstress} = \begin{cases} 1 \text{ if stress score} \geq 110 \\ 0 \text{ if not} \end{cases}$$

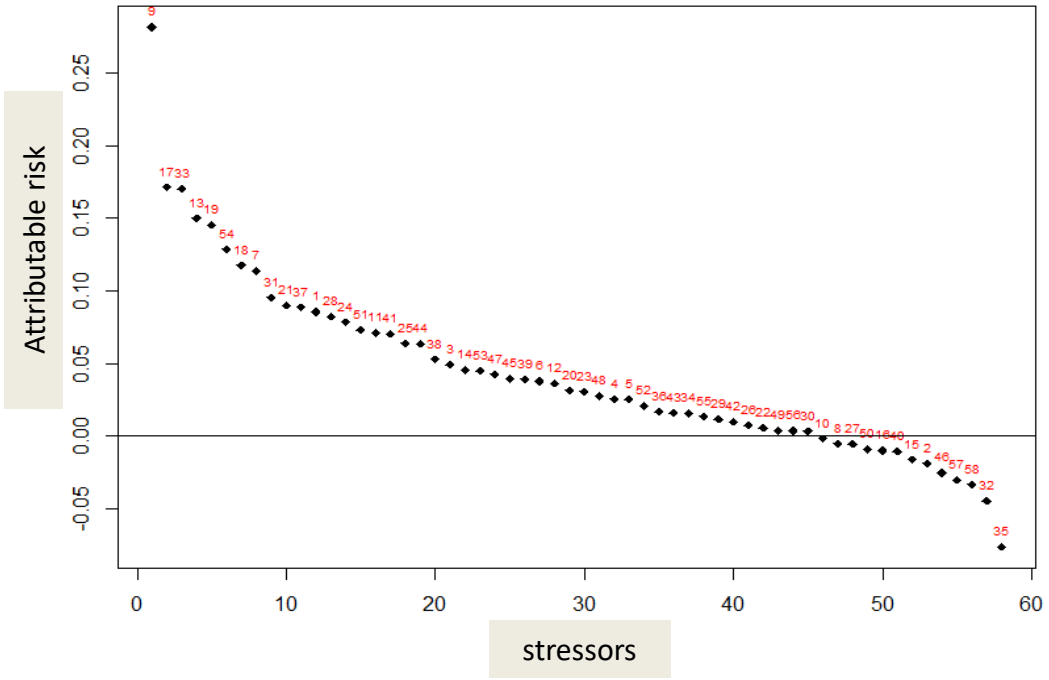
can be evaluated by estimating an odds-ratio → logistic regression

Items	OR	95% Confidence Interval (OR)	
nsp09	3,81	3,21	4,52
nsp13	1,57	1,31	1,87
nsp54	1,49	1,27	1,76
nsp25	1,74	1,38	2,19
nsp18	1,37	1,16	1,61
nsp03	1,37	1,12	1,68
nsp37	1,28	1,09	1,51
nsp01	1,28	1,08	1,50
nsp38	1,34	1,10	1,63

3. Attributable risk (2)

The OR does not consider the exposure rate to the stressor.

We suggest to calculate an attributable risk for each factor, as a measure of performance.



Ranking

Weifila	AR	R. Forest
nsp09	nsp09	nsp09
nsp54	nsp13	nsp25
nsp25	nsp54	nsp54
nsp14	nsp24	nsp45
nsp13	nsp41	nsp13
nsp44	nsp25	nsp03

Stressors to improve

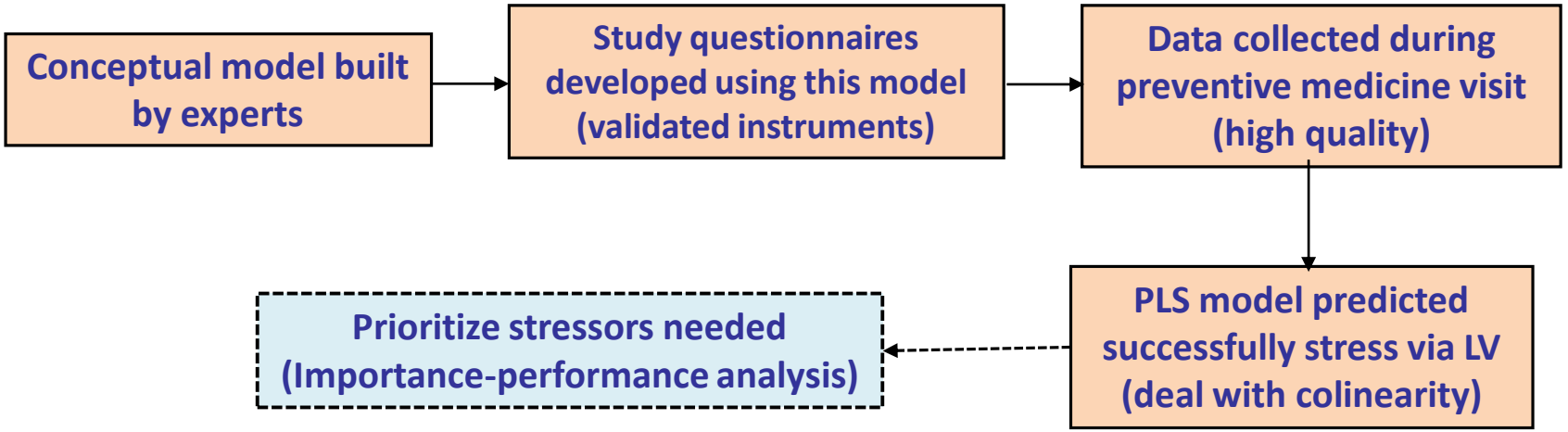
1. « I have to work fast in a short timeframe »
2. « My promotion prospects are weak »
3. inverse of « My company offers me interesting career opportunities »
4. « I work in a noisy and hectic atmosphere »
5. inverse of « I am rewarded when I reach my goals »

Stressors to maintain

1. « I frequently see the work pile up without being able to eliminate the backlog »
2. inverse of « My work gives me many opportunities to perform interesting tasks »
3. inverse of « My work means a lot to me »
4. « My job is about monotonous and repetitive tasks »
5. inverse of « I can achieve professional life - personal life balance »
6. « I'm living or I expect to live an undesirable change that might affect my career »

Conclusion

- Sequence of the performed approach:



- Attributable Risk based approach is a useful tool easy to implement to help managers to rank professional psychosocial factors regarding their impact on stress level.

Perspectives

Causal analysis: to determine stressors on which to act in order to reduce psychosocial disorders associated with stress.

➔ Causal graphs (Bühlmann, P. 2013)

➔ Validation using longitudinal data collection

References

1. Henri Wallard. Using Explained Variance Allocation to analyse Importance of Predictors. 16th ASMDA Conference Proceedings, 30 June – 4 July 2015, Piraeus, Greece

2. Clarke, S. G., & Cooper, C. L. The risk management of occupational stress. Health, Risk & Society 2000.

3. Vinzi, E, Russolillo, G. Partial least squares algorithms and methods. Wiley Interdisciplinary Reviews: Computational Statistics 2013.

4. Martilla, J. A., & James, J. C. Importance-performance analysis. The journal of marketing 1977.

5. Bühlmann, P. Causal statistical inference in high dimensions. Mathematical Methods of Operations Research 2013.

Outcome of interest

Two different outcomes related to the level of stress.

Continuous variable:

- Y_1= stress score

Binary variable of "over-stress":

- $Y_2 = \begin{cases} 1 \text{ if stress score} \geq 110 \\ 0 \text{ if not.} \end{cases}$