Developing a scale to measure factors influencing skier's self-perceived group dynamics (FISSGD)

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1 Data Wrangling

For the interest of space, codes in this section will not be shown. Yet they are available in the .rmd file.

1.1 Read in the data

1.2 Combine 2022 and 2023 data

1.3 Remove careless responses (according to attention trap)

Q10_2 and Q10_5, as well as Q19_1 and Q19_4 were same questions with different wordings. If the responses had conflictory results between them, they were regarded as careless responses.

1.4 Replace value of -99 with NA

1.5 Unify value labels

Values of some of the variables had been inconsistently labeled. They were unified here.

1.6 Relabel variables

Properly label the variables so that the interpretation can be better managed.

1.7 Replace "Don't know" with NAs

1.8 Create data sets

Four data sets were created. They are a. 18 item with leader; b. 6 item with leader; c. 17 item without leader; d. 5 item without leader; 3. background. The case identifier is "index" variable across data sets.

1.8.1 Create data set: 17 item without leader

1.8.2 Create data set: 5 item without leader

1.8.3 Create data set: 20 item with leader

1.8.4 Create data set: 6 item with leader

2 Descriptive statistics

Table 1: Descriptive statistics for with-leader group (long)

				Central tendency		Dispersion tendency			
	n	Question	n of NA	Mean	Median	SD	Min	Max	Q1~Q3
i_leader1	100	The leader (formal or informal) was the best suited person in the group to make the decisions.	4	4.1	4.0	1.0	1.0	6.0	4.0 ~ 5.0
i_leader2	100	The leader (formal or informal) communicated openly and clearly	4	4.3	4.0	0.8	1.0	6.0	4.0 ~ 5.0
i_leader3	100	Everyone could voice their concerns to the leader (formal or informal)	4	4.6	5.0	0.7	1.0	6.0	4.0 ~ 5.0
i_skill1	101	The least knowledgeable group member could conduct satisfactory avalanche assessments for this trip	3	3.2	4.0	1.3	1.0	6.0	2.0 ~ 4.0
i_skill2	101	There was no large gap in avalanche assessment skills between the group members	3	2.5	2.0	1.3	1.0	6.0	1.0 ~ 4.0
i_skill3	101	There was no important difference in skiing skill level between group members, given the terrain	3	2.9	3.0	1.4	1.0	6.0	2.0 ~ 4.0
i_skill4	101	All group members were equipped with standard avalanche safety equipment (beacon, shovel, probe) and trained in the use of it	3	4.3	5.0	1.1	1.0	6.0	4.0 ~ 5.0
i_orga1	102	The group members knew each other well	2	3.9	4.0	1.2	1.0	5.0	3.0 ~ 5.0
i_orga2	101	The group size was appropriate for the trip (time, difficulty)	3	4.5	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_orga3	102	The roles of the group members were clearly defined	2	3.3	3.0	1.2	1.0	6.0	2.0 ~ 4.0
i_orga4	102	Some or all group members met each other for the first time on this trip	2	2.1	1.0	1.6	1.0	5.0	1.0 ~ 2.0
i_comm1	101	Decisions concerning avalanche hazard were well discussed in the group	3	4.1	4.0	0.9	2.0	6.0	4.0 ~ 5.0
i_comm2	101	Everyone in the group understood the decisions that were made	3	4.1	4.0	1.0	1.0	6.0	4.0 ~ 5.0
i_comm3	101	Everyone voiced their concerns whenever they felt necessary	3	4.0	4.0	1.1	1.0	6.0	3.0 ~ 5.0
i_iden1	102	There were clear expectations of each group member	2	3.4	3.0	1.0	1.0	6.0	3.0 ~ 4.0
i_iden2	102	Everyone was happy with the decisions that were made	2	4.3	4.0	1.0	2.0	6.0	4.0 ~ 5.0
i_anom1	100	The group decisions at the decision points were unanimous	4	4.0	4.0	1.1	1.0	6.0	4.0 ~ 5.0
i_anom2	101	Someone tried to impress others.	3	2.0	2.0	1.0	1.0	6.0	1.0 ~ 2.0
i_anom3	101	Love stories were going on in the group	3	2.3	1.0	1.6	1.0	6.0	1.0 ~ 4.0
i_anom4	101	The presence of other groups impacted my group's decision making	3	2.0	1.0	1.3	1.0	6.0	1.0 ~ 3.0

Table 2: Descriptive statistics for without-leader group (long)

				Central tendency		Dispersion tendency			
	n	Question	n of NA	Mean	Median	SD	Min	Max	Q1~Q3
i_skill1	117	The least knowledgeable group member could conduct satisfactory avalanche assessments for this trip	4	3.6	4.0	1.2	1.0	5.0	2.0 ~ 5.0
i_skill2	117	There was no large gap in avalanche assessment skills between the group members	4	3.2	3.0	1.3	1.0	5.0	2.0 ~ 4.0
i_skill3	117	There was no important difference in skiing skill level between group members, given the terrain	4	3.6	4.0	1.3	1.0	5.0	2.0 ~ 5.0
i_skill4	117	All group members were equipped with standard avalanche safety equipment (beacon, shovel, probe) and trained in the use of it	4	4.5	5.0	1.0	1.0	6.0	4.0 ~ 5.0
i_orga1	115	The group members knew each other well	6	4.2	5.0	1.1	1.0	5.0	4.0 ~ 5.0
i_orga2	115	The group size was appropriate for the trip (time, difficulty)	6	4.6	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_orga3	115	The roles of the group members were clearly defined	6	3.2	3.0	1.4	1.0	6.0	2.0 ~ 5.0
i_orga4	115	Some or all group members met each other for the first time on this trip	6	1.7	1.0	1.3	1.0	6.0	1.0 ~ 2.0
i_comm1	117	Decisions concerning avalanche hazard were well discussed in the group	4	4.0	4.0	1.0	1.0	5.0	4.0 ~ 5.0
i_comm2	117	Everyone in the group understood the decisions that were made	4	4.4	5.0	0.9	1.0	6.0	4.0 ~ 5.0
i_comm3	117	Everyone voiced their concerns whenever they felt necessary	4	4.3	4.0	1.0	1.0	6.0	4.0 ~ 5.0
i_iden1	116	There were clear expectations of each group member	5	3.6	4.0	1.0	1.0	5.0	3.0 ~ 4.0
i_iden2	116	Everyone was happy with the decisions that were made	5	4.4	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_anom1	116	The group decisions at the decision points were unanimous	5	4.2	4.0	1.1	2.0	6.0	4.0 ~ 5.0
i_anom2	116	Someone tried to impress others.	5	1.9	2.0	1.2	1.0	6.0	1.0 ~ 2.0
i_anom3	116	Love stories were going on in the group	5	1.8	1.0	1.3	1.0	6.0	1.0 ~ 2.0
i_anom4	116	The presence of other groups impacted my group's decision making	5	2.2	2.0	1.5	1.0	6.0	1.0 ~ 4.0

Table 3: Descriptive statistics for with-leader group (short)

				Central tendency		Dispersion tendency			
	n	Question	n of NA	Mean	Median	SD	Min	Max	Q1~Q3
i_leader0	100	The decisions were followed by all group members.	4	4.7	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_skill0	101	The level of avalanche assessment and rescue skills differed greatly across the group.	3	3.4	4.0	1.4	1.0	6.0	2.0 ~ 4.0
i_orga0	102	The group was well	2	3.9	4.0	0.9	1.0	5.0	3.0 ~ 4.0
i_comm0	102	The communication in the group was good	2	4.4	4.0	0.7	2.0	6.0	4.0 ~ 5.0
i_iden0	101	The group was cohesive and had a shared vision	3	4.2	4.0	0.8	2.0	6.0	4.0 ~ 5.0
i_anom0	101	Social interactions in the group negatively impacted decision	3	1.8	1.0	1.2	1.0	6.0	1.0 ~ 2.0

Table 4: Descriptive statistics for without-leader group (short)

				Central tendency		Dispersion tendency			
	n	Question	n of NA	Mean	Median	SD	Min	Max	Q1~Q3
i_skill0	117	The level of avalanche assessment and rescue skills differed greatly across the group.	4	2.7	2.0	1.4	1.0	6.0	2.0 ~ 4.0
i_orga0	116	The group was well	5	4.1	4.0	0.9	2.0	5.0	4.0 ~ 5.0
i_comm0	117	The communication in the group was good	4	4.3	5.0	0.9	1.0	5.0	4.0 ~ 5.0
i_iden0	116	The group was cohesive and had a shared vision	5	4.2	4.0	0.8	1.0	5.0	4.0 ~ 5.0
i_anom0	115	Social interactions in the group negatively impacted decision	6	1.9	2.0	1.1	1.0	6.0	1.0 ~ 2.0

3 Visualization

3.1 Distribution

Figure 1 Distributions of the item for with−leader group (long

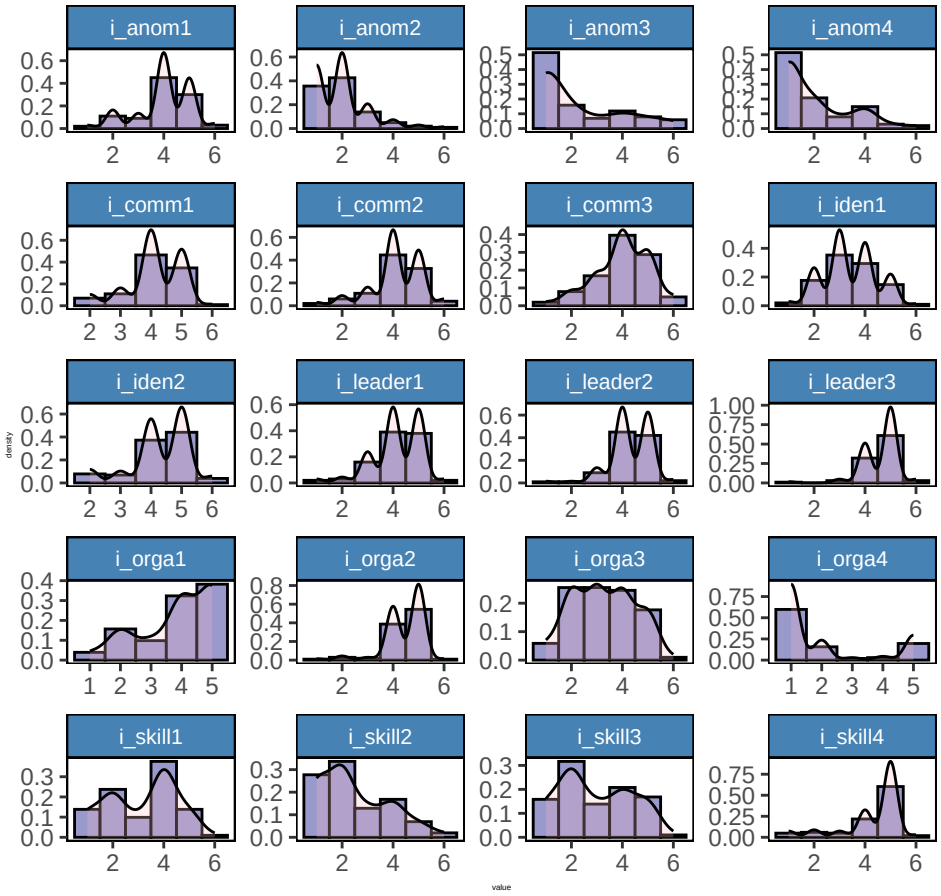


Figure 2 Distribtuions of the item for without−leader group (lo

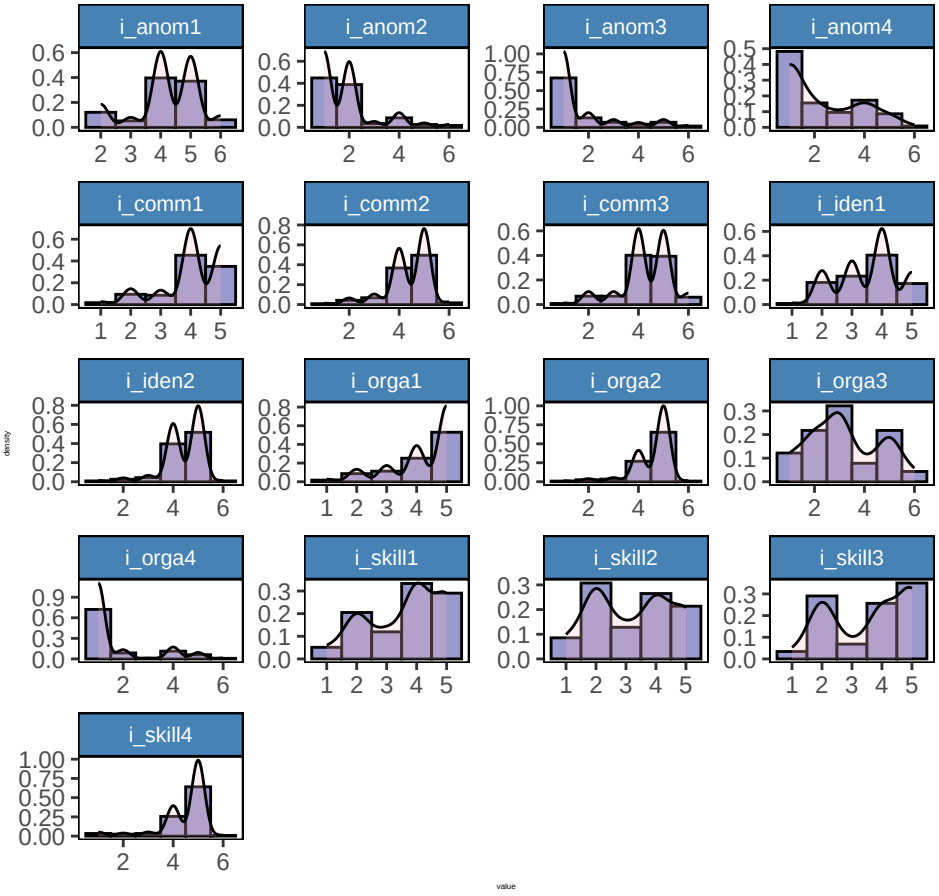


Figure 3 Distributions of the item for with−leader group (short)

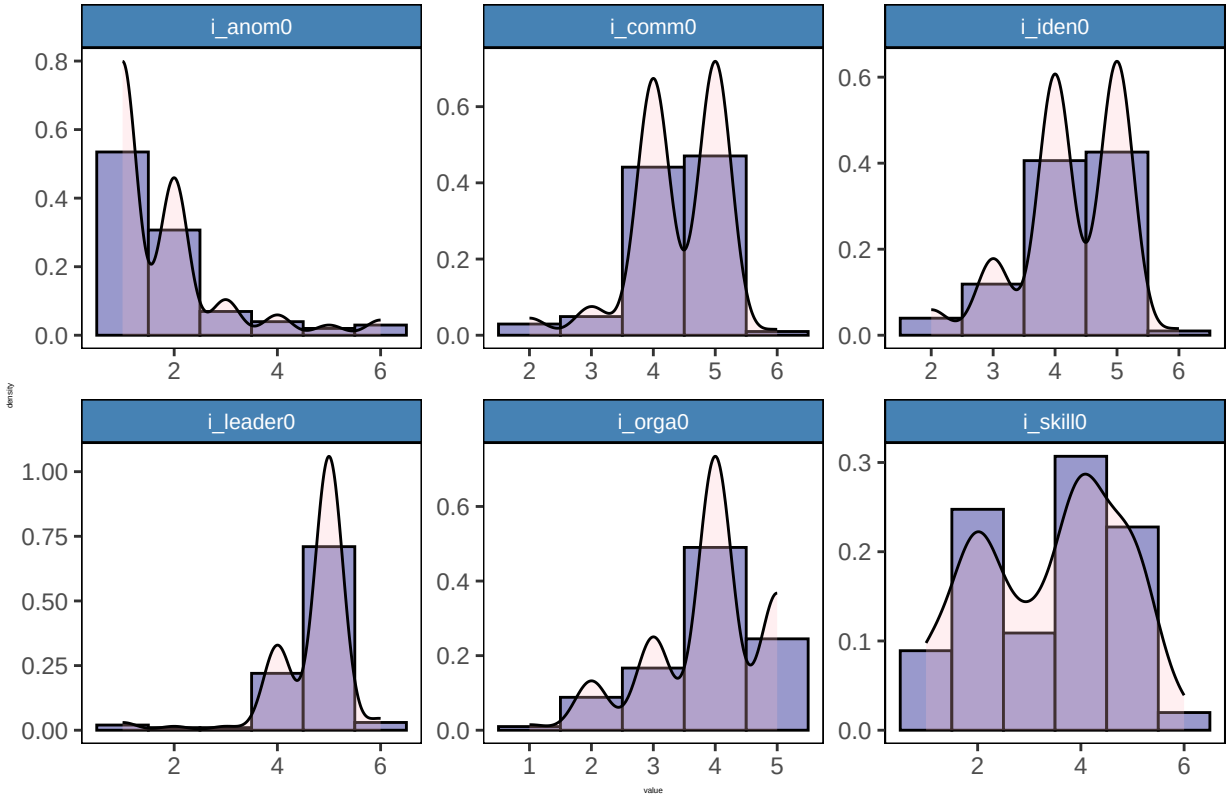
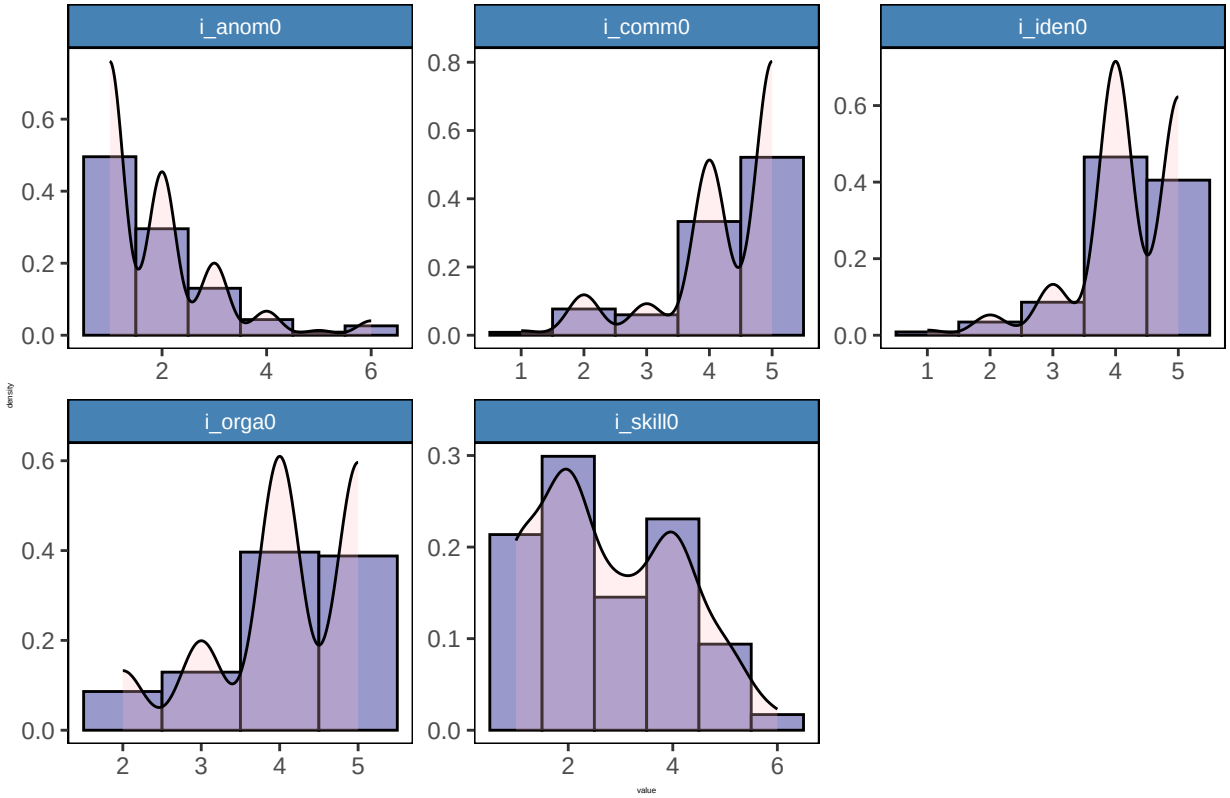


Figure 4 Distributions of the item for without−leader group (short)



3.2 Correlation matrix

Figure 51 Correlation matrix of the item for with−leader group (long)

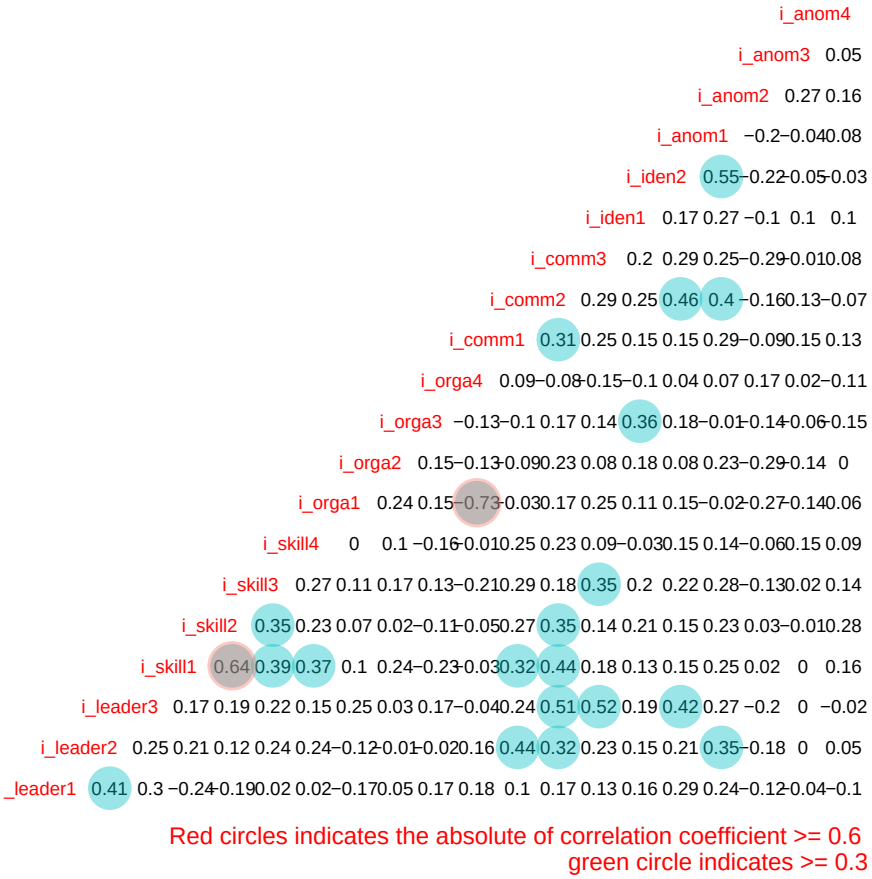
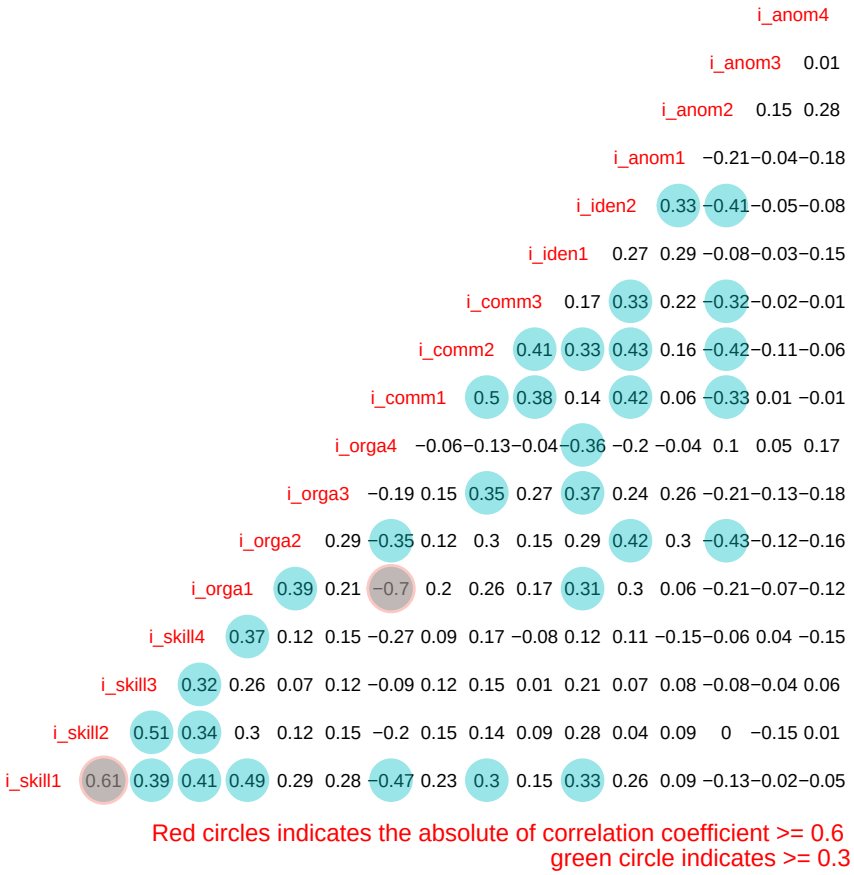


Figure 6 Correlation matrix of the item for without−leader group (long)



Red circles indicates the absolute of correlation coefficient >= 0.6
green circle indicates >= 0.3

Figure 7 Correlation matrix of the item for with−leader group (short)

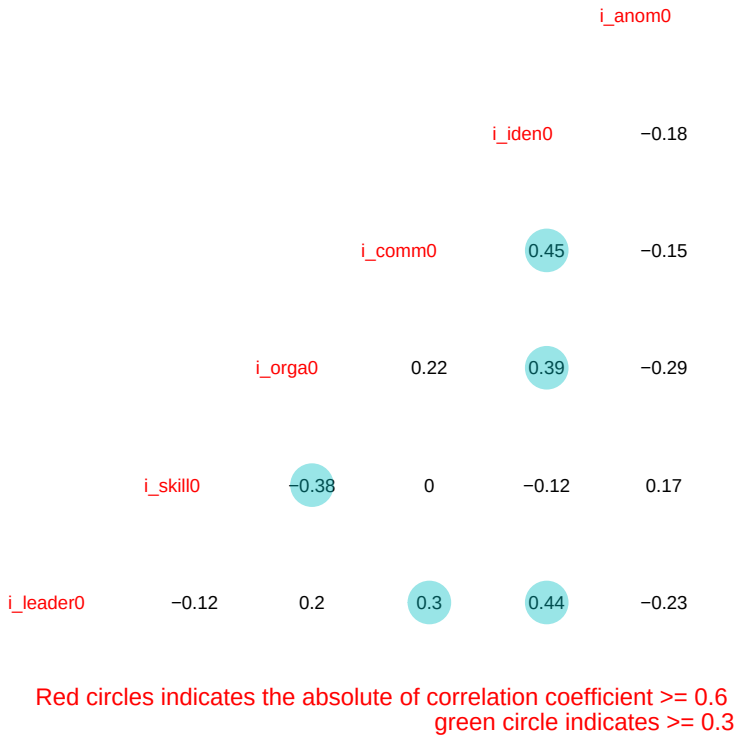
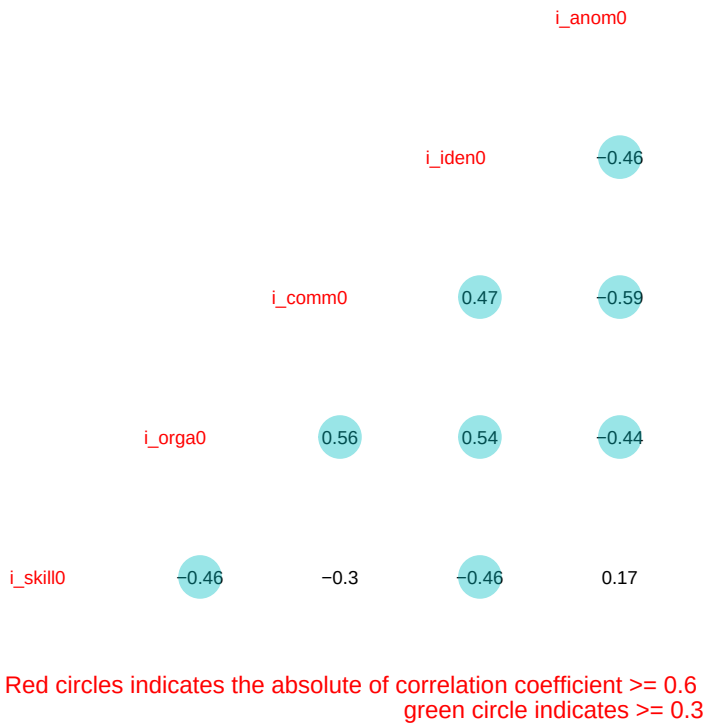


Figure 8 Correlation matrix of the item for without−leader group (short)



4 Impute NAs

Impute NAs with medians.

Table 5: Results of KMO test of sampling adequacy for with-leader group (long)

	KMO.ldr20
i_leader1	0.613
i_leader2	0.719
i_leader3	0.741
i_skill1	0.647
i_skill2	0.726
i_skill3	0.687
i_skill4	0.779
i_orga1	0.530
i_orga2	0.434
i_orga3	0.503
i_orga4	0.480
i_comm1	0.805
i_comm2	0.715
i_comm3	0.814
i_iden1	0.683
i_iden2	0.668
i_anom1	0.727
i_anom2	0.671
i_anom3	0.398
i_anom4	0.550
Overall	0.657

Table 6: Results of bartlett test for with-leader group (long)

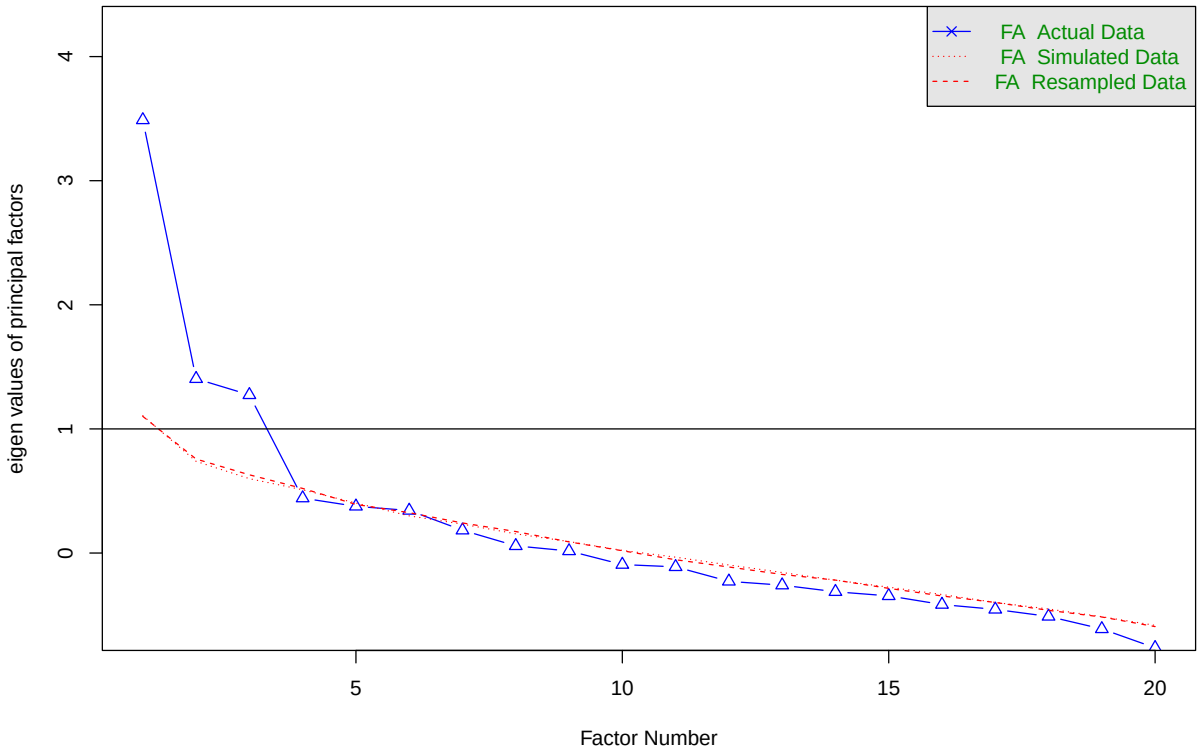
Chi-square	p-value	DF
625.862	<0.001	190

5 Factor analysis for with-leader group (long)

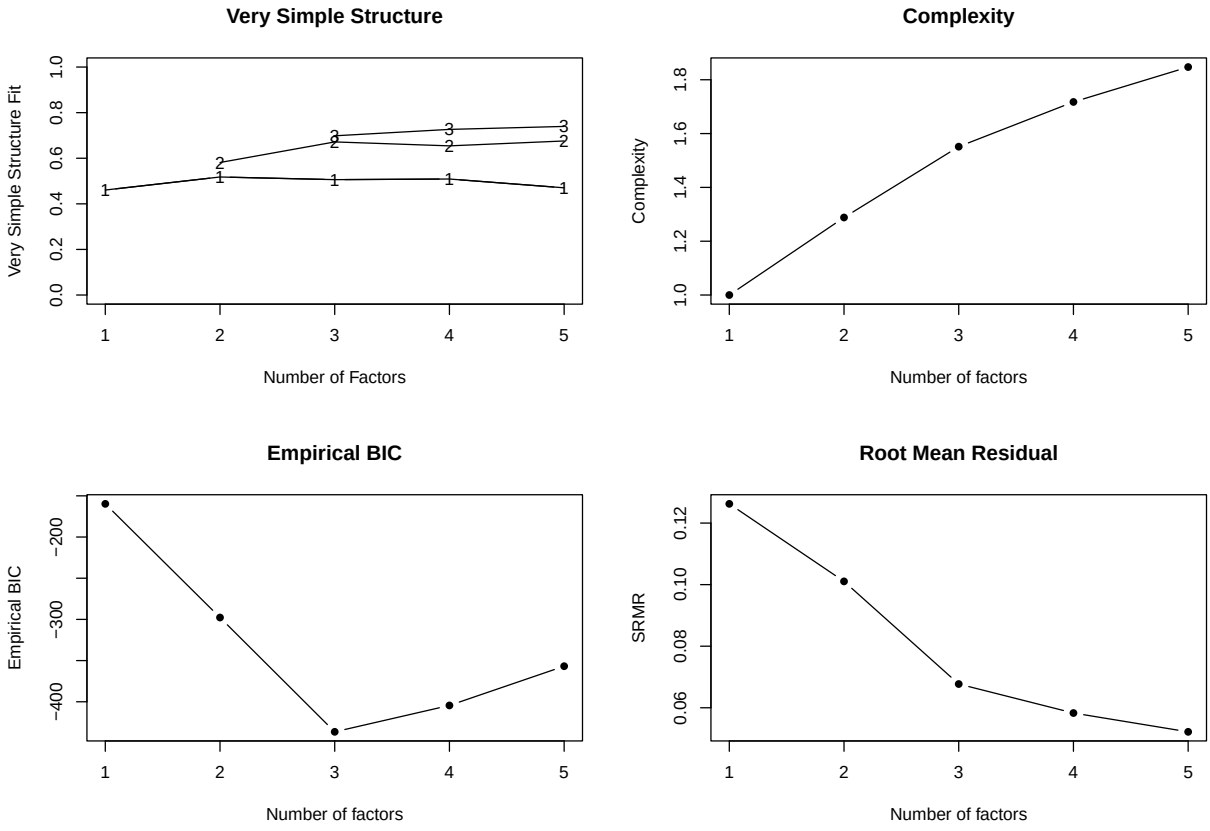
5.1 Check factoribility

5.2 Explore number of factors

Figure 9. Scree plot for with−leader group (long)




```
## Parallel analysis suggests that the number of factors =  3  and the number of components =  NA
```




```
##
## Number of factors
## Call: vss(x = x, n = n, rotate = rotate, diagonal = diagonal, fm = fm,
##     n.obs = n.obs, plot = FALSE, title = title, use = use, cor = cor)
## VSS complexity 1 achieves a maximimum of 0.52  with  2  factors
## VSS complexity 2 achieves a maximimum of 0.68  with  5  factors
## The Velicer MAP achieves a minimum of 0.02  with  3  factors
## Empirical BIC achieves a minimum of  -436.5  with  3  factors
## Sample Size adjusted BIC achieves a minimum of  -21.77  with  5  factors
##
## Statistics by number of factors
##   vss1 vss2   map dof chisq    prob sqresid  fit RMSEA  BIC SABIC complex
## 1 0.46 0.00 0.027 170   399 1.6e-20    20.1 0.46 0.114 -390   147     1.0
## 2 0.52 0.58 0.029 151   288 1.2e-10    15.6 0.58 0.093 -413    64     1.3
## 3 0.51 0.67 0.024 133   182 2.9e-03    11.2 0.70 0.059 -435   -15     1.6
## 4 0.51 0.65 0.029 116   153 1.3e-02     9.7 0.74 0.054 -386   -20     1.7
## 5 0.47 0.68 0.031 100   127 3.7e-02     8.6 0.77 0.050 -338   -22     1.8
##   eChisq  SRMR eCRMS eBIC
## 1    630 0.126 0.133 -160
## 2    404 0.101 0.113 -298
## 3    181 0.068 0.081 -436
## 4    134 0.058 0.075 -404
## 5    108 0.052 0.072 -357
```

5.3 Explore factor solutions

5.3.1 Explore 5-factor solution

Figure 10. Five−factor solution, with−leader group (long)

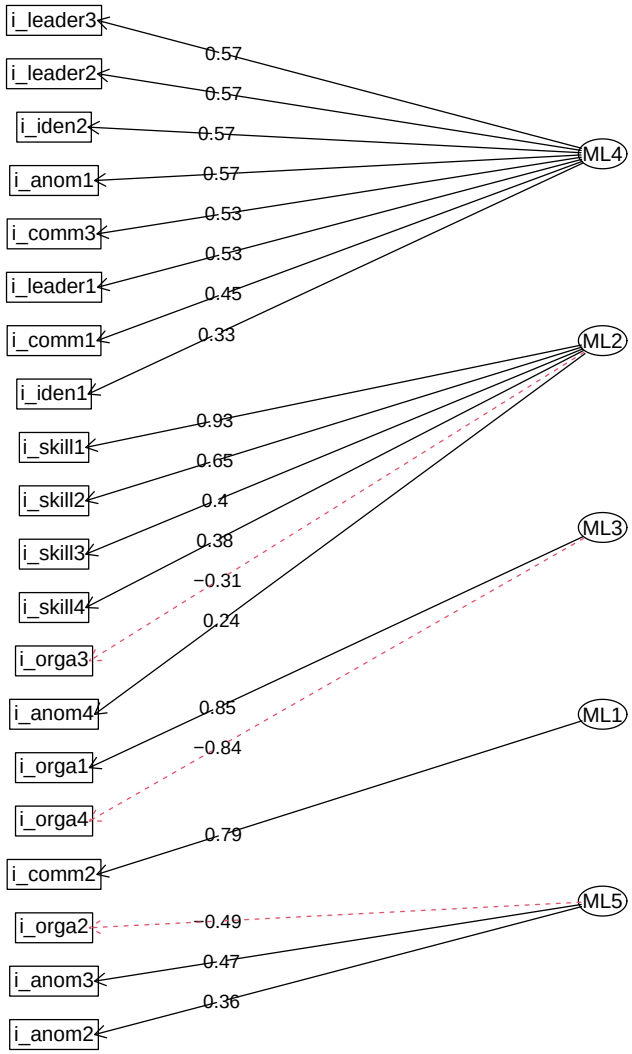


Table 7: Factor loadings of the 5-factor solution for with-leader group (long)

Item	ML4	ML2	ML3	ML1	ML5
i_leader1	0.527				
i_leader2	0.571				
i_leader3	0.575				
i_skill1		0.933			
i_skill2		0.651			
i_skill3	0.388	0.399			
i_skill4		0.383			
i_orga1			0.851		
i_orga2					
i_orga3					
i_orga4					
i_comm1	0.446	0.36			
i_comm2	0.516			0.788	
i_comm3	0.527				
i_iden1	0.329				
i_iden2	0.569				
i_anom1	0.565				
i_anom2					0.364
i_anom3					0.472
i_anom4					

5.3.2 Explore 4-factor solution

Figure 11. Four−factor solution, with−leader group (long)

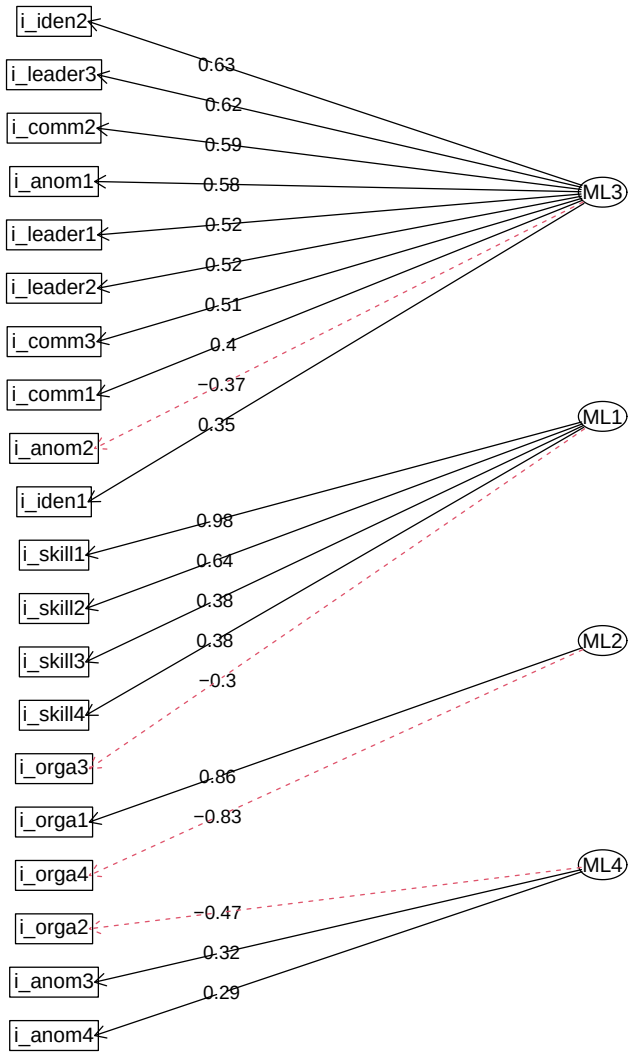


Table 8: Factor loadings of the 4-factor solution for with-leader group (long)

Item	ML3	ML1	ML2	ML4
i_leader1	0.522			
i_leader2	0.518			
i_leader3	0.624			
i_skill1		0.979		
i_skill2		0.637		
i_skill3	0.327	0.378		
i_skill4		0.378		
i_orga1			0.863	
i_orga2				
i_orga3				
i_orga4				
i_comm1	0.395	0.35		0.375
i_comm2	0.59	0.36		
i_comm3	0.506			
i_iden1	0.348			
i_iden2	0.631			
i_anom1	0.576			
i_anom2				
i_anom3				0.325
i_anom4				

5.3.3 Explore 3-factor solution

Figure 12. Three−factor solution, with−leader group (long)

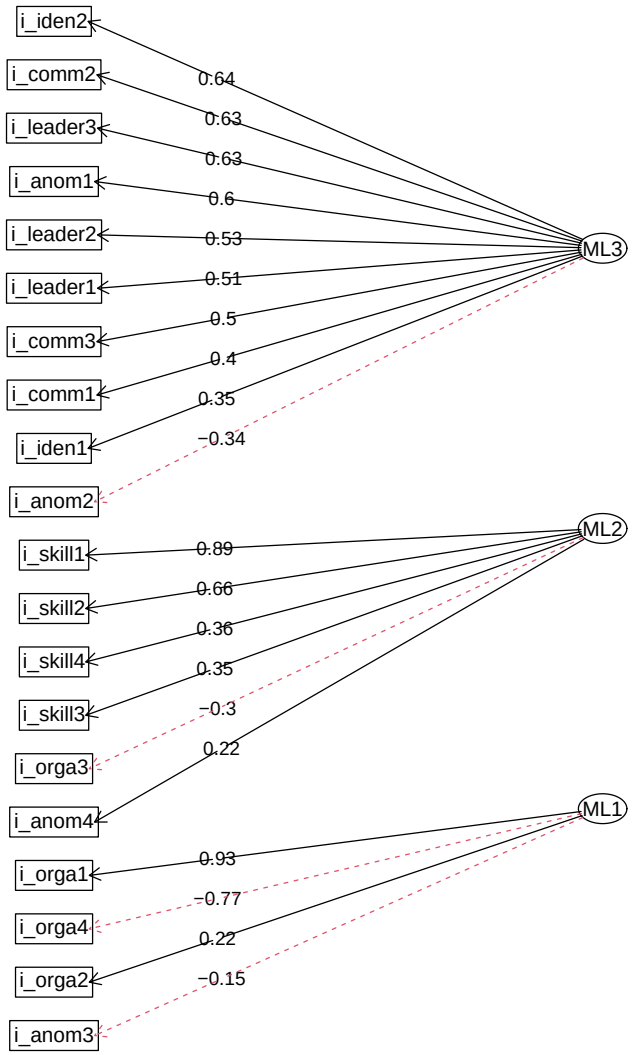


Table 9: Factor loadings of the 3-factor solution for with-leader group (long)

Item	ML3	ML2	ML1
i_leader1	0.515		
i_leader2	0.535		
i_leader3	0.627		
i_skill1		0.891	
i_skill2		0.657	
i_skill3	0.349	0.352	
i_skill4		0.359	
i_orga1			0.931
i_orga2			
i_orga3			
i_orga4			
i_comm1	0.399		
i_comm2	0.629	0.309	
i_comm3	0.496		
i_iden1	0.351		
i_iden2	0.637		
i_anom1	0.598		
i_anom2			
i_anom3			
i_anom4			

Table 10: Factor loadings of the 3-factor solution for with-leader group (long)

Item	ML3	ML1	ML2
i_leader1	0.352		0.489
i_leader2			0.823
i_leader3	0.636		
i_skill1		0.914	
i_skill2		0.67	
i_skill3		0.389	
i_skill4		0.389	
i_orga3	0.407		
i_comm1		0.341	0.422
i_comm2	0.592	0.387	
i_comm3	0.467		
i_iden1	0.375		
i_iden2	0.648		

5.3.4 Finetune 3-factor solution

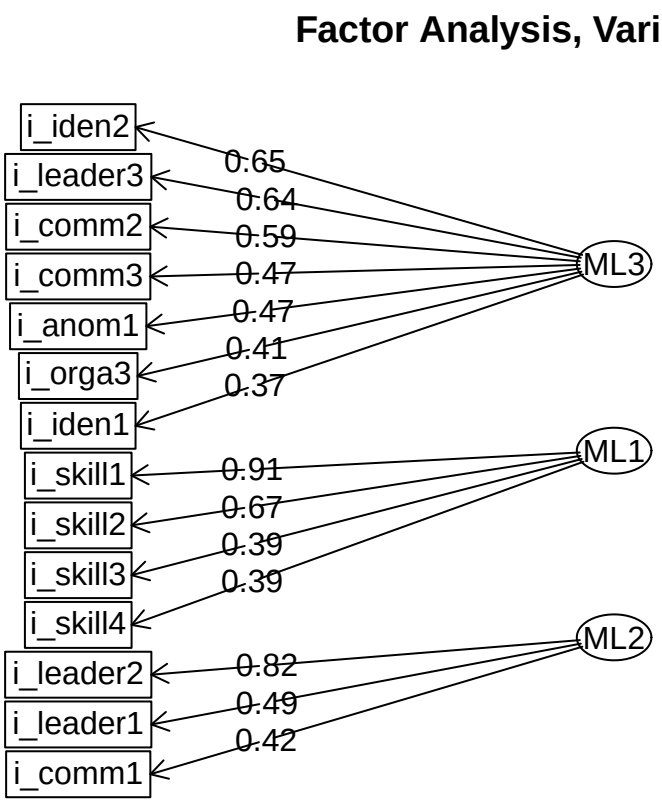


Table 11: Comparison between factor solutions, with-leader (long)

	CumulativeVariance
3-factor(tuned)	0.4095194
3-factor	0.3508653
4-factor	0.3915083
5-factor	0.4310159

Table 12: Final items for 3 factor solution, with-leader group (long)

	Item
ML2: Leadership Quality	
i_iden2	Everyone was happy with the decisions that were made
i_anom1	The group decisions at the decision points were unanimous
i_leader3	Everyone could voice their concerns to the leader (formal or informal)
i_comm3	Everyone voiced their concerns whenever they felt necessary
i_leader1	The leader (formal or informal) was the best suited person in the group to make the decisions.
i_leader2	The leader (formal or informal) communicated openly and clearly
i_comm2	Everyone in the group understood the decisions that were made
i_orga3	The roles of the group members were clearly defined
ML3: Skill	
i_skill1	The least knowledgeable group member could conduct satisfactory avalanche assessments for this trip
i_skill2	There was no large gap in avalanche assessment skills between the group members
i_skill4	All group members were equipped with standard avalanche safety equipment (beacon, shovel, probe) and trained in the use of it
i_skill3	There was no important difference in skiing skill level between group members, given the terrain
ML1: Individual contribution	
i_comm1	Decisions concerning avalanche hazard were well discussed in the group
i_iden1	There were clear expectations of each group member

Table 13: Results of KMO test of sampling adequacy for with-leader group (short)

	KMO
i_leader0	0.717
i_skill0	0.599
i_orga0	0.653
i_comm0	0.712
i_iden0	0.660
i_anom0	0.738
Overall	0.677

Table 14: Results of bartlett test for with-leader group (short)

Chi-square	p-value	DF
90.944	<0.001	15

5.3.5 Comparison between factor solutions, with-leader (long)

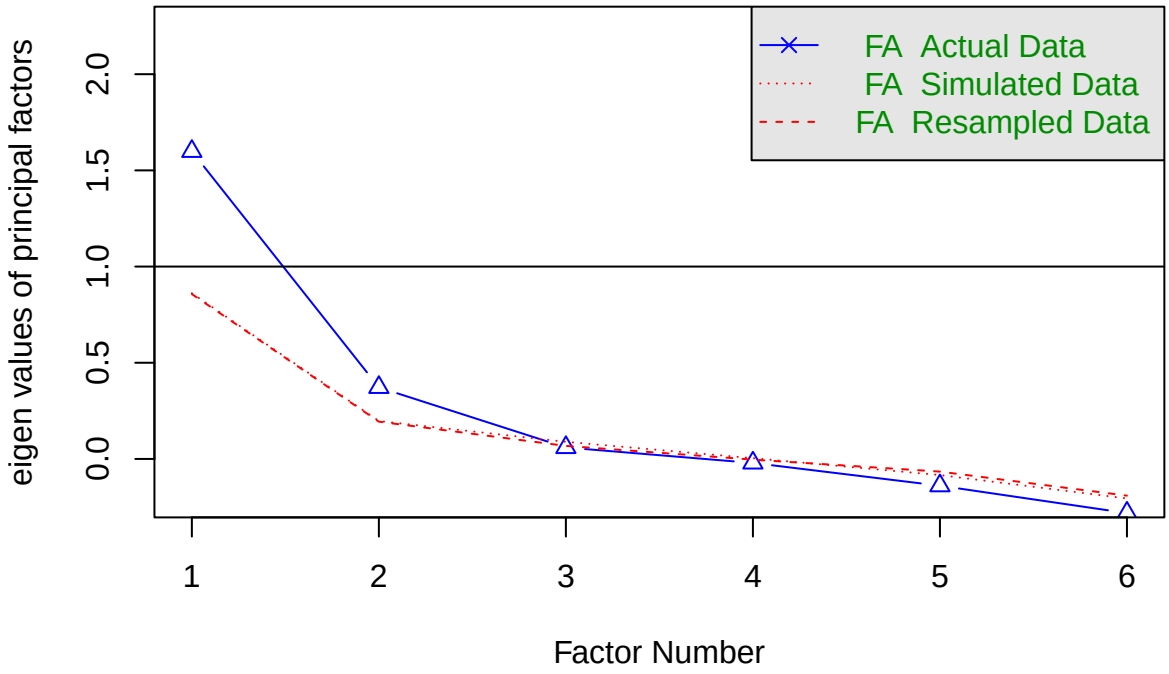
5.3.6 Check the factor connotation for 3-factor solution (fine-tuned)

6 Factor analysis for with-leader group (short)

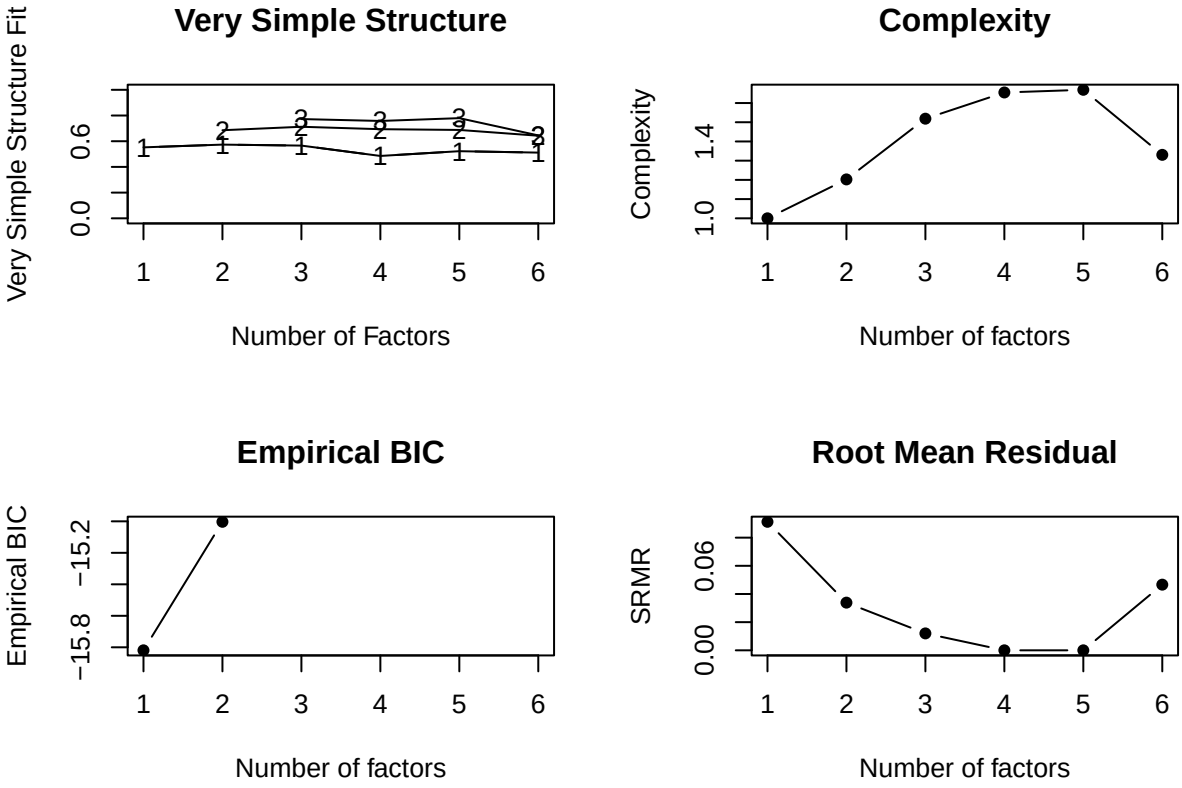
6.1 Check factoribility

6.2 Explore number of factors

figure 14. Scree plot, wiht−leader group (short)




```
## Parallel analysis suggests that the number of factors =  2  and the number of components =  NA
```




```
##
## Number of factors
## Call: vss(x = x, n = n, rotate = rotate, diagonal = diagonal, fm = fm,
##     n.obs = n.obs, plot = FALSE, title = title, use = use, cor = cor)
## VSS complexity 1 achieves a maximimum of 0.57  with  2  factors
## VSS complexity 2 achieves a maximimum of 0.71  with  3  factors
## The Velicer MAP achieves a minimum of 0.06  with  1  factors
## Empirical BIC achieves a minimum of  -15.82  with  1  factors
## Sample Size adjusted BIC achieves a minimum of  -2.43  with  2  factors
##
## Statistics by number of factors
##   vss1 vss2   map dof   chisq  prob sqresid  fit RMSEA BIC SABIC complex
## 1 0.55 0.00 0.061   9 1.9e+01 0.023     3.7 0.55   0.1 -23   5.9     1.0
## 2 0.57 0.69 0.109   4 3.5e+00 0.475     2.6 0.69   0.0 -15  -2.4     1.2
## 3 0.57 0.71 0.211   0 3.3e-01    NA     1.9 0.77    NA  NA    NA     1.5
## 4 0.49 0.69 0.430  -3 9.5e-13    NA     1.9 0.77    NA  NA    NA     1.7
## 5 0.52 0.69 1.000  -5 5.2e-13    NA     1.4 0.82    NA  NA    NA     1.7
## 6 0.51 0.64    NA  -6 6.7e+00    NA     2.9 0.65    NA  NA    NA     1.3
##    eChisq    SRMR eCRMS eBIC
## 1 2.6e+01 9.1e-02 0.118  -16
## 2 3.6e+00 3.4e-02 0.066  -15
## 3 4.5e-01 1.2e-02    NA   NA
## 4 1.1e-12 1.9e-08    NA   NA
## 5 6.3e-13 1.4e-08    NA   NA
## 6 6.8e+00 4.7e-02    NA   NA
```

Table 15: Factor loadings of the 5-factor solution for with-leader group (long)

Item	ML1	ML2
i_leader0	0.524	
i_skill0		
i_orga0		0.765
i_comm0	0.575	
i_iden0	0.752	
i_anom0		

6.2.1 Explore 2-factor solution

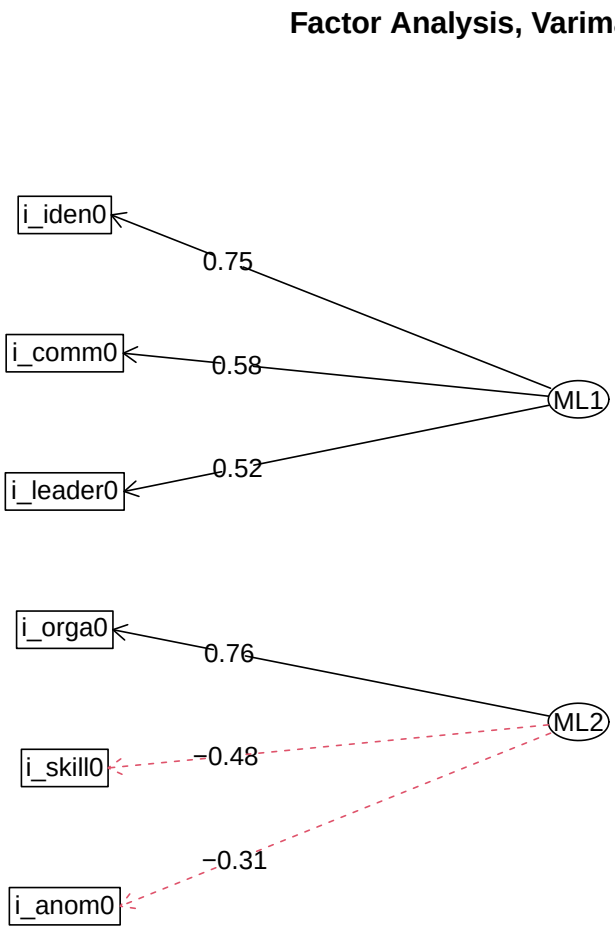


Table 16: Factor loadings of the 5-factor solution for with-leader group (long)

Item	ML2	ML3	ML1
i_leader0			0.971
i_skill0			
i_orga0	0.925		
i_comm0		0.909	
i_iden0	0.313	0.442	0.315
i_anom0			

6.2.2 Explore 3-factor solution