

Research Methods

Factor Analysis

Andy Gillett

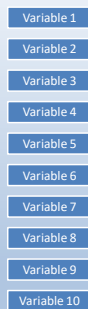
1

Factor Analysis

Factor analysis is a statistical technique for analysing the correlations between a number of variables in order to reduce them to a smaller number of underlying dimensions, called factors, and to determine the correlation of each of the original variables with each factor.

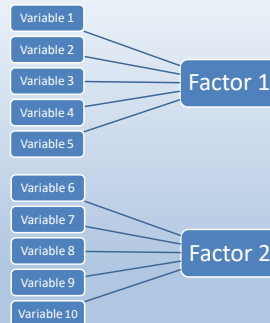
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Factor Analysis



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Factor Analysis



The amount of the total variance explained by that factor is called the **eigenvalue** of a factor.

The extent to which a particular variable contributes to a given factor is the **factor loading** of a variable.

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Factor Analysis

Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1. interest	Numeric	8	2	job interest	None	None	8	Right	Scale	Input
2. expertise	Numeric	8	2	rating of expertise	None	None	8	Right	Scale	Input
3. health	Numeric	8	2	healthiness of work	None	None	8	Right	Scale	Input
4. personal	Numeric	8	2	relationships with colleagues	None	None	8	Right	Scale	Input
5. personal	Numeric	8	2	relationships for promotion and development	None	None	8	Right	Scale	Input
6. work/life	Numeric	8	2	balance of work	None	None	8	Right	Scale	Input
7. holidays	Numeric	8	2	holidays	None	None	8	Right	Scale	Input

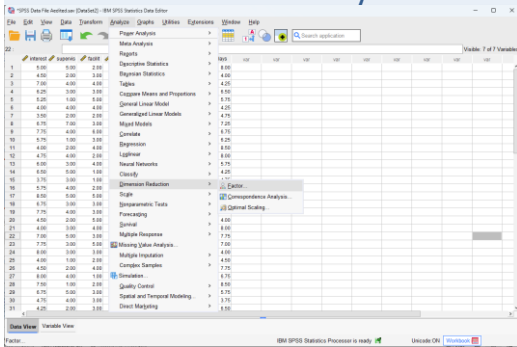
5

Factor Analysis

Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1. interest	Numeric	8	2	job interest	None	None	8	Right	Scale	Input
2. expertise	Numeric	8	2	rating of expertise	None	None	8	Right	Scale	Input
3. health	Numeric	8	2	healthiness of work	None	None	8	Right	Scale	Input
4. personal	Numeric	8	2	relationships with colleagues	None	None	8	Right	Scale	Input
5. personal	Numeric	8	2	relationships for promotion and development	None	None	8	Right	Scale	Input
6. work/life	Numeric	8	2	balance of work	None	None	8	Right	Scale	Input
7. holidays	Numeric	8	2	holidays	None	None	8	Right	Scale	Input

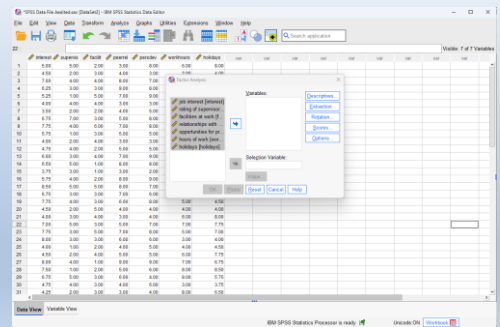
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Factor Analysis



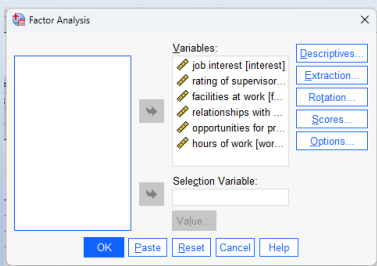
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Factor Analysis



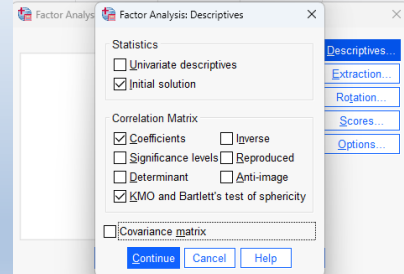
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Factor Analysis



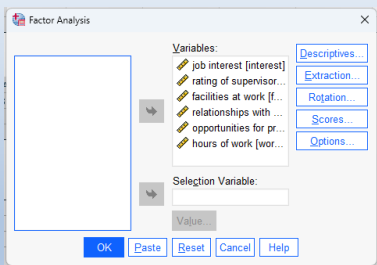
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Factor Analysis



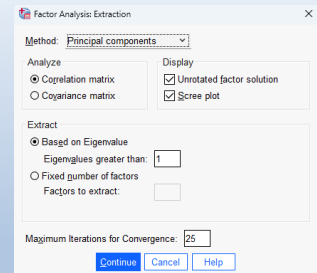
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Factor Analysis



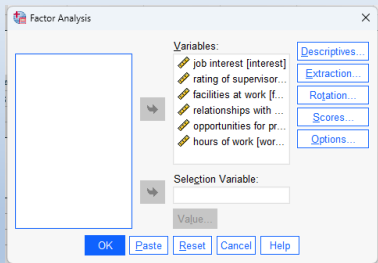
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Factor Analysis



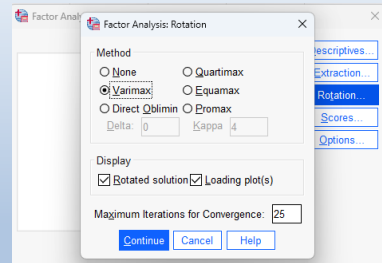
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Factor Analysis



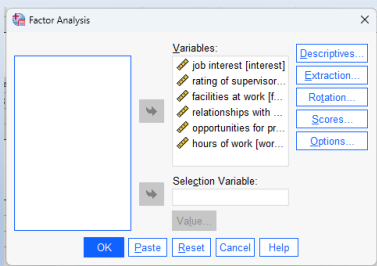
13

Factor Analysis



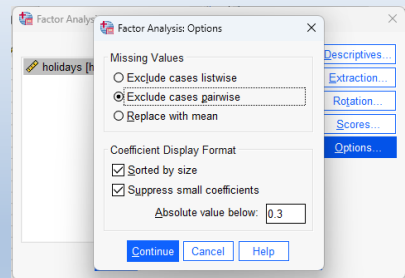
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Factor Analysis



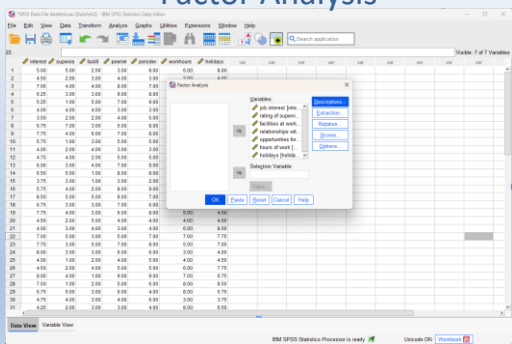
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Factor Analysis



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Factor Analysis



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Factor Analysis

Correlation Matrix						
	job interest	rating of supervisor	facilities at work	relationships with colleagues	opportunities for promotion and development	hours of work
Correlation	1.000	.350	.019	.516	.527	.031
job interest						
rating of supervisor	.350	1.000	-.098	.052	.235	.008
facilities at work	.019	-.098	1.000	.107	.114	.035
relationships with colleagues	.516	.052	.107	1.000	.625	.071
opportunities for promotion and development	.527	.235	.114	.625	1.000	.057
hours of work	.031	.008	.035	.071	.057	1.000

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Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.654
Bartlett's Test of Sphericity	Approx. Chi-Square	45.167
	df	15
	Sig.	<.001

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Factor Analysis

Communalities

	Initial	Extraction
job interest	1.000	.699
rating of supervisor	1.000	.596
facilities at work	1.000	.566
relationships with colleagues	1.000	.709
opportunities for promotion and development	1.000	.730
hours of work	1.000	.086

Extraction Method: Principal Component Analysis.

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Factor Analysis

Component	Initial Eigenvalues			Total Variance Explained			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.240	37.330	37.330	2.240	37.330	37.330	2.238	37.295	37.295
2	1.146	19.093	56.423	1.146	19.093	56.423	1.148	19.129	56.423
3	.983	16.386	72.810						
4	.839	13.989	86.799						
5	.455	7.579	94.378						
6	.337	5.622	100.000						

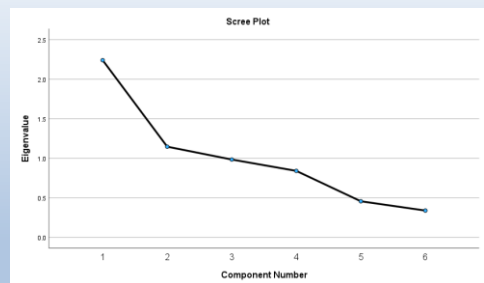
Extraction Method: Principal Component Analysis.

The eigenvalue of a factor represents the amount of the total variance explained by that factor.

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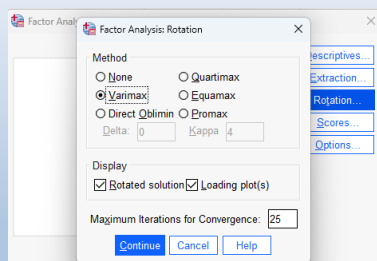
Factor Analysis



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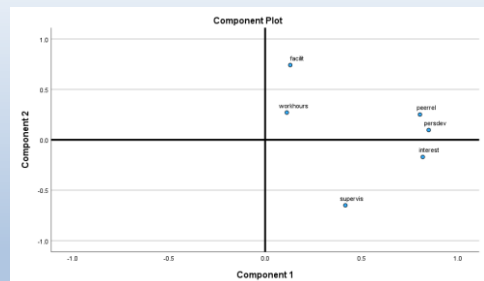
Factor Analysis



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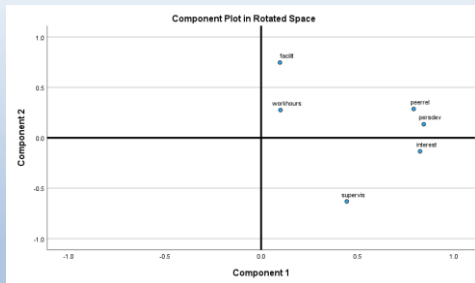
Factor Analysis



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Factor Analysis



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Factor Analysis

Component	Initial Eigenvalues			Total Variance Explained			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.240	37.330	37.330	2.240	37.330	37.330	2.238	37.285	37.285
2	1.146	19.093	56.423	1.146	19.093	56.423	1.148	19.129	56.423
3	.893	13.989	72.810						
4	.839	13.989	86.799						
5	.455	7.579	94.378						
6	.337	5.622	100.000						

Extraction Method: Principal Component Analysis.

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Factor Analysis

Component Matrix ^a		
	Component	
	1	2
opportunities for promotion and development	.849	
job interest	.818	
relationships with colleagues	.804	
facilities at work		.741
rating of supervisor	.417	-.650
hours of work		

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

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Factor Analysis

Rotated Component Matrix ^a		
	Component	
	1	2
opportunities for promotion and development	.844	
job interest	.825	
relationships with colleagues	.792	
facilities at work		.746
rating of supervisor	.445	-.631
hours of work		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

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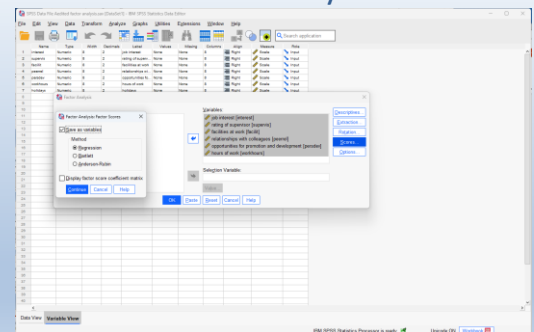
Factor Analysis

Component Transformation Matrix		
Component	1	2
1	.999	.044
2	-.044	.999

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

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Factor Analysis



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Factor Analysis

IBM SPSS Data File Analysis Editor [Dataset1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

Search application

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Format	Role
1	name	String	2	0	job interview	None	None	8	Left	None	None
2	type	String	2	0	type of car	None	None	8	Left	None	None
3	size	String	2	0	size of car	None	None	8	Left	None	None
4	color	String	2	0	color of car	None	None	8	Left	None	None
5	label	String	2	0	label of car	None	None	8	Left	None	None
6	values	String	2	0	values of car	None	None	8	Left	None	None
7	missing	String	2	0	missing of car	None	None	8	Left	None	None
8	weight	String	2	0	weight of car	None	None	8	Left	None	None
9	age	String	2	0	age of car	None	None	8	Left	None	None
10	sex	String	2	0	sex of car	None	None	8	Left	None	None
11	hair_color	String	2	0	hair color of car	None	None	8	Left	None	None
12	PAID_1	String	11	0	PAID for car	None	None	15	Left	None	None
13	PAID_2	String	11	0	PAID for car	None	None	15	Left	None	None

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 68

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Factor Analysis

The screenshot shows the RStudio interface with a data frame named 'mpg' loaded. The data frame has 32 rows and 11 columns. The columns are: name, displ, year, cyl, drv, flt, wt, qsec, hwy, mtcars, and class. The data is displayed in a table view with alternating light blue and white rows. The first few rows of data are:

	name	displ	year	cyl	drv	flt	wt	qsec	hwy	mtcars	class
1	4-cyl	181	1973	4	f	l	2.620	16.99	21.4	mtcars	4-cyl
2	8-cyl	351	1973	8	r	l	5.253	17.71	19.2	mtcars	8-cyl
3	4-cyl	260	1975	4	f	l	2.875	16.46	18.7	mtcars	4-cyl
4	4-cyl	258	1976	4	f	l	2.731	16.46	18.7	mtcars	4-cyl
5	4-cyl	258	1977	4	f	l	2.731	16.46	18.7	mtcars	4-cyl

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Factor Analysis

Factor analysis, using principal components extraction and varimax rotation, was performed on the data. Two factors were extracted, Factor 1 explaining 37.3 per cent of the variance in the original measures and Factor 2 explaining an additional 19.0 per cent of the variance. The first three variables were found to have high factor loadings (.84, .82 & .79) on Factor 1, and the fourth variable a high factor loading (.75) on Factor 2.

Based on Colman & Pulford (2008).

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Research Methods

Factor Analysis 2

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Factor Analysis

[illegible]

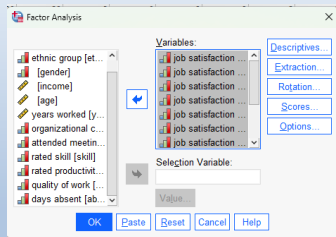
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Factor Analysis

The screenshot displays the Microsoft Excel 2010 application window. The title bar reads "Microsoft Excel - [Book1.xlsx] - File Home Insert Page Layout Formulas Data Review View". The ribbon tabs are visible: File, Home, Insert, Page Layout, Formulas, Data, Review, and View. The main workspace shows a spreadsheet with 25 columns and 25 rows. The columns are labeled "Year", "Year 2", "Year 3", "Year 4", "Year 5", "Year 6", "Year 7", "Year 8", "Year 9", "Year 10", "Year 11", "Year 12", "Year 13", "Year 14", "Year 15", "Year 16", "Year 17", "Year 18", "Year 19", "Year 20", "Year 21", "Year 22", "Year 23", "Year 24", and "Year 25". The rows are labeled "1" through "25". The data is organized into a grid with alternating light blue and white cells. The "Year" column contains values from 1 to 25. The "Year 2" column contains values from 1 to 25. The "Year 3" column contains values from 1 to 25. The "Year 4" column contains values from 1 to 25. The "Year 5" column contains values from 1 to 25. The "Year 6" column contains values from 1 to 25. The "Year 7" column contains values from 1 to 25. The "Year 8" column contains values from 1 to 25. The "Year 9" column contains values from 1 to 25. The "Year 10" column contains values from 1 to 25. The "Year 11" column contains values from 1 to 25. The "Year 12" column contains values from 1 to 25. The "Year 13" column contains values from 1 to 25. The "Year 14" column contains values from 1 to 25. The "Year 15" column contains values from 1 to 25. The "Year 16" column contains values from 1 to 25. The "Year 17" column contains values from 1 to 25. The "Year 18" column contains values from 1 to 25. The "Year 19" column contains values from 1 to 25. The "Year 20" column contains values from 1 to 25. The "Year 21" column contains values from 1 to 25. The "Year 22" column contains values from 1 to 25. The "Year 23" column contains values from 1 to 25. The "Year 24" column contains values from 1 to 25. The "Year 25" column contains values from 1 to 25. The status bar at the bottom indicates "Data View" and "Variable View".

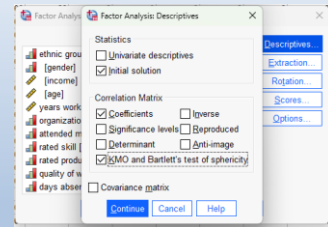
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Factor Analysis



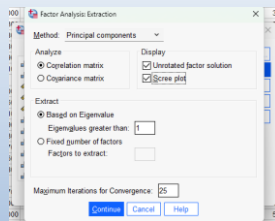
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Factor Analysis



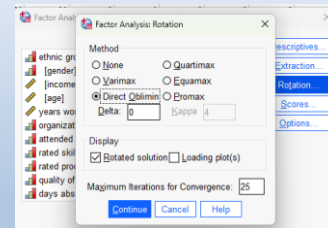
38

Factor Analysis



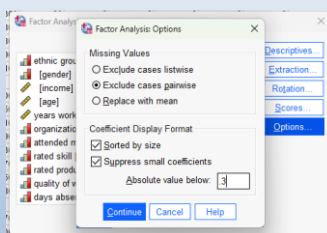
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Factor Analysis



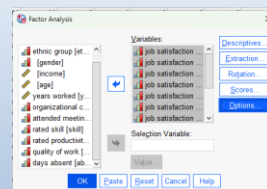
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Factor Analysis



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Factor Analysis



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Factor Analysis

Correlation Matrix

	job satisfaction item1	job satisfaction item2	job satisfaction item3	job satisfaction item4	job satisfaction item5	job satisfaction item6	job satisfaction item7	job satisfaction item8	job satisfaction item9	job satisfaction item10	job satisfaction item11	job satisfaction item12
job satisfaction item1	1.000	.438	.478	.442	.586	.481	.489	.579	.488	.480	.388	.301
job satisfaction item2	.438	1.000	.374	.478	.586	.588	.435	.449	.521	.497	.428	.403
job satisfaction item3	.478	.374	1.000	.543	.487	.244	.338	.294	.301	.224	.284	.247
job satisfaction item4	.442	.478	.543	1.000	.488	.288	.341	.334	.454	.344	.343	.303
job satisfaction item5	.586	.588	.487	.488	1.000	.488	.413	.416	.358	.324	.327	.323
job satisfaction item6	.481	.588	.244	.288	.488	1.000	.348	.388	.438	.379	.343	.423
job satisfaction item7	.489	.435	.338	.341	.413	.348	1.000	.448	.388	.381	.353	.338
job satisfaction item8	.579	.449	.294	.334	.416	.388	.448	1.000	.388	.382	.348	.338
job satisfaction item9	.488	.521	.301	.454	.358	.438	.388	.388	1.000	.888	.798	.728
job satisfaction item10	.480	.497	.224	.454	.324	.379	.381	.382	.888	1.000	.828	.758
job satisfaction item11	.388	.428	.284	.343	.327	.343	.353	.348	.798	.828	1.000	.838
job satisfaction item12	.301	.403	.247	.303	.323	.423	.338	.338	.728	.758	.838	1.000

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Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.827
Bartlett's Test of Sphericity	Approx. Chi-Square
df	418.961
Sig.	66
	<.001

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Factor Analysis

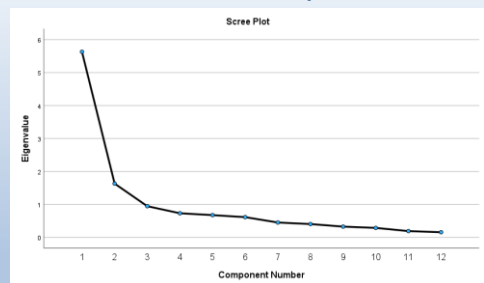
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings ^a			Rotation Sums of Squared Loadings ^a
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.631	46.925	46.925	5.631	46.925	46.925	4.689
2	1.629	13.571	60.497	1.629	13.571	60.497	4.471
3	.942	7.851	68.348				
4	.728	6.063	74.411				
5	.671	5.595	80.006				
6	.610	5.083	85.089				
7	.447	3.722	88.811				
8	.400	3.330	92.141				
9	.322	2.685	94.826				
10	.283	2.358	97.184				
11	.186	1.551	98.735				
12	.152	1.265	100.000				

Extraction Method: Principal Component Analysis.
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

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Factor Analysis



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Factor Analysis

Component Matrix^a

	Component	
	1	2
job satisfaction item9	.789	.467
job satisfaction item2	.746	
job satisfaction item1	-.739	
job satisfaction item5	-.715	.409
job satisfaction item11	.708	.503
job satisfaction item10	.707	.367
job satisfaction item12	.675	.512
job satisfaction item6	-.675	
job satisfaction item4	.662	
job satisfaction item8	-.660	.436
job satisfaction item3	-.556	.333
job satisfaction item7	-.548	.428

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

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Factor Analysis

Pattern Matrix^a

	Component	
	1	2
job satisfaction item5	-.829	
job satisfaction item8	-.822	
job satisfaction item7	-.745	
job satisfaction item1	-.689	
job satisfaction item3	-.660	
job satisfaction item4	.614	
job satisfaction item2	.473	.395
job satisfaction item6	-.400	-.385
job satisfaction item9		.900
job satisfaction item11		.891
job satisfaction item12		.882
job satisfaction item10		.755

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 6 iterations.

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Factor Analysis

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.631	46.925	46.925	5.631	46.925	46.925
2	1.629	13.571	60.497	1.629	13.571	60.497
3	.942	7.851	68.348			
4	.728	6.063	74.411			
5	.671	5.595	80.006			
6	.610	5.083	85.089			
7	.447	3.722	88.811			
8	.400	3.330	92.141			
9	.322	2.685	94.826			
10	.283	2.358	97.184			
11	.186	1.551	98.735			
12	.152	1.265	100.000			

Extraction Method: Principal Component Analysis.
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

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Factor Analysis

Component Correlation Matrix

Component	1	2
1	1.000	.476
2	.476	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

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Factor Analysis

Pattern Matrix^a

	Component	
	1	2
job satisfaction item5	-.829	
job satisfaction item8	-.822	
job satisfaction item7	-.745	
job satisfaction item1	-.689	
job satisfaction item3	-.660	
job satisfaction item4	.614	
job satisfaction item2	.473	.395
job satisfaction item6	-.400	-.385
job satisfaction item9		.900
job satisfaction item11		.891
job satisfaction item12		.882
job satisfaction item10		.755

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 6 iterations.

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Factor Analysis

Structure Matrix

	Component	
	1	2
job satisfaction item5	-.824	-.383
job satisfaction item8	-.789	-.321
job satisfaction item1	-.766	-.490
job satisfaction item7	-.686	
job satisfaction item4	.684	.440
job satisfaction item2	.660	.619
job satisfaction item3	-.648	
job satisfaction item6	-.593	-.576
job satisfaction item9	.463	.916
job satisfaction item11	.375	.867
job satisfaction item12	.342	.845
job satisfaction item10	.440	.793

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

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Factor Analysis

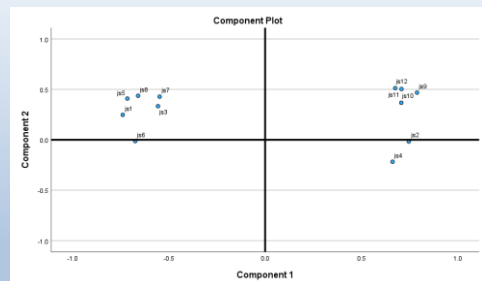
Communalities

	Initial	Extraction
job satisfaction item1	1.000	.608
job satisfaction item2	1.000	.557
job satisfaction item3	1.000	.420
job satisfaction item4	1.000	.485
job satisfaction item5	1.000	.679
job satisfaction item6	1.000	.455
job satisfaction item7	1.000	.483
job satisfaction item8	1.000	.626
job satisfaction item9	1.000	.840
job satisfaction item10	1.000	.634
job satisfaction item11	1.000	.754
job satisfaction item12	1.000	.719

Extraction Method: Principal Component Analysis.

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Factor Analysis



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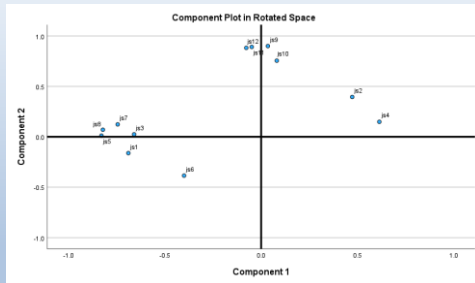
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Factor Analysis



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Factor Analysis

The 12 items of the Job Satisfaction Scale were subjected to principal components analysis (PCA) using SPSS version 28. Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .65, exceeding the recommended value of .6 (Kaiser 1970, 1974) and Bartlett's Test of Sphericity (Bartlett 1954) reached statistical significance, supporting the factorability of the correlation matrix.

Principal components analysis revealed the presence of two components with eigenvalues exceeding 1, explaining 37.3% and 19.0% of the variance respectively. An inspection of the screeplot revealed a clear break after the second component. Using Catell's (1966) scree test, it was decided to retain two components for further investigation.

The two-component solution explained a total of 56.4% of the variance, with Component 1 contributing 37.3% and Component 2 contributing 19.0%. To aid in the interpretation of these two components, oblimin rotation was performed. The rotated solution revealed the presence of simple structure (Thurstone 1947), with both components showing a number of strong loadings and all variables loading substantially on only one component. There was a moderately strong positive correlation between the two factors ($r = .476$).

Based on Pallant (2016).

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