A machine has a record of producing 80% excellent, 17% good, and 3% unacceptable parts. After extensive repairs, a sample of 200 produced 157 excellent, 42 good, and 1 unacceptable part. Have the repairs changed the nature of the output of the machine? Use SPSS with $\alpha = 0.05$.

1. Enter the data into one variable (Quality: 1 = Excellent, 2 = Good, 3 = Unacceptable) so that there are 157 Excellent (1), 42 Good (2), and 1 Unacceptable (3). This method enters raw data.

or

Enter the category values into one variable and the observed frequencies into another variable (*see left figure, below*). Then weight the category values variable by the observed frequencies variable (*see two right figures, below*). This method enters tabulated data.

Data Transform Analyze Graphs U Define Variable Properties Copy Data Properties New Custom Attribute Define Dates Define Dates Define Multiple Response Sets Define Network Define Network		
Identify Duplicate Cases Sort Cases Transpose Restructure Merge Files Aggregate	Quality [quality] Do not weight cases Veight cases by Frequency Variable: Current Status: Do not weight cases	OK Paste Reset Cancel Help
Copy Dataset Split File Select Cases Weight Cases		

	quality	count
1	Excellent	157
2	Good	42
3	Unacceptable	1

- 2. Select Analyze \rightarrow Nonparametric Tests \rightarrow Chi-Square... (see left figure, below).
- 3. Select "Quality" as the test variable and enter the values for the null hypothesis proportions in numerical order by category value [*i.e.*, P(Excellent) = $\pi_{1,0}$ = 0.80, then P(Good) = $\pi_{2,0}$ = 0.17, then P(Unacceptable) = $\pi_{3,0}$ = 0.03] (*see right figure, below*).

Analyze Graphs Utilities A	Add-ons Window Help			
Reports Descriptive Statistics Tables		Chi-Square Test		X
Compare Means General Linear Model Generalized Linear Models Mixed Models Correlate Regression	Var Var	✓ How Many? [count]	Test Variable List:	OK Paste Reset Cancel
Loglinear Classify		Expected Range	Expected Values	Help
Data Reduction	•	 Get from data 	 All categories equal 	
Scale	•	O Use specified range	Values:	
Nonparametric Tests	 Chi-Square 	Lower	08. bbA	
Time Series	 Binomial 		.17	
Survival	Runs	Upper:	Change .U3	
Multiple Response	1-Sample K-S	-	Remove	
Missing Value Analysis	2 Independent Samples	_		Options
Quality Control	K Independent Samples			
ROC Curve	2 Related Samples			
	K Related Samples			

4. Your output gives the expected frequencies table (Step 4.1), the Chi-Square test statistic and *p*-value (Step 4.3), as well as a footnote for checking the assumptions (Step 4.2).

Chi-Square Test				
Frequencies				
Quality				
	Observed N	Expected N	Residual	
Excellent	157	160.0000	-3.0	
Good	42	34.0000	8.0	
Unacceptable	1	6.0000	-5.0	
Total	200			
Test Statistics				
	Quality			
Chi-Square ª	6.1053			
df	2			
Asymp. Sig.	.0472			
 a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0. 				

Step 1: Hypotheses

- *H*₀: The repairs did not change the nature of the output of the machine. [*i.e.*, the proportions remained the same ($\pi_1 = 0.80$, $\pi_2 = 0.17$, $\pi_3 = 0.03$)]
- *H_a*: The repairs did change the nature of the output of the machine. [*i.e.*, the proportions changed after the repairs (at least one $\pi_i \neq \pi_{i,0}$)]
- Step 2: Significance Level

 $\alpha = 0.05$

Step 3: Rejection Region

Reject the null hypothesis if *p*-value $\leq 0.05 = \alpha$.

Step 4.1: Calculate Expected Frequencies

	Observed N	Expected N	Residual
Excellent	157	160.0000	-3.0
Good	42	34.0000	8.0
Unacceptable	1	6.0000	-5.0
Total	200		

Step 4.2: Check Assumptions

According to footnote *a* (below), all expected frequencies are \geq 5 (smallest value is 6).

Step 4.3: Test Statistic and P-value

Test Statistics			
	Quality		
Chi-Square ^a	6.1053		
df	2		
Asymp. Sig.	.0472		
a. 0 cells (.0%) have expected			

0 cells (.0%) have expected frequencies less than
 5. The minimum expected cell frequency is 6.0.

Step 5: Decision

Since *p*-value = $0.0472 \le 0.05$, we shall reject the null hypothesis.

Step 6: State conclusion in words

At the α = 0.05 level of significance, there is enough evidence to conclude that the repairs changed the nature of the output of the machine (the proportions are not what they used to be).