A note on SCL Koh's paper 'MRP-controlled batch-manufacturing environment under uncertainty'

In Koh's recent paper,[1] MRP planning and batch-manufacturing system control architectures were modelled using simulation. An experimental design was set up in which there were eight main effects, 28 two-way interactions and 56 three-way interactions. Results were analysed using SPSS, and effects that were significant at the 5% level were reported and elaborated upon. Four of the main effects, two of the two-way interactions and four of the three-way interactions were significant at the 5% level.

One important aspect of this methodology not commented upon in the paper is that results significant at a 5% level are expected to occur purely due to chance on one in 20 occasions. Hence, in the 92 significance tests carried out in the paper, four or five should be expected to be significant at the 5% level for no other reason than chance. This has some implications for the conclusions drawn in the paper.

Inspecting the results more carefully the four significant main effects are all significant at the 0.5% significance level, and hence provide strong evidence of real effects.

Of the 28 two-way effects, one is significant at 0.1% level, but the second is only significant at the 5% level. Hence, while the evidence for the former is again strong, evidence for the latter is rather weak.

Finally, all four of the significant three-way effects are only significant at the 5% level. Given that $56 \times 5\% = 2.8$ 'significant' results 'should' occur simply due to chance, this is very weak evidence.

In general, researchers need to be aware of this potential weakness in situations where many significance tests are performed, and should interpret their results accordingly.

However, in cases such as this particular paper, where results have been produced using simulated experiments, there is another option. Repetition of the simulated experiments using another set of random numbers will either support the tentative initial findings or will demonstrate that they were just a chance occurrence.

References

1 Koh SCL (2004). MRP-controlled batch-manufacturing environment under uncertainty. *J Opl Res Soc* **55**: 219–232.

Lancaster University   D Worthington

Comment on Dave Worthington's note on Koh SCL (2004): MRP-controlled batch-manufacturing environment under uncertainty

First of all, I would like to thank Dave for pointing out this issue in his note. When I was designing the simulation experiments, the issue of 'occurrence simply due to chance' or 'statistical fluke' hit me. If this is a mathematical model, then the results might not be strong. However, this is a simulation study. In the study, those uncertainty factors were randomized by the default random number streams in SIMAN–SEEDS element as Pegden et al[1] suggested that, in many cases, it is not important which stream is used.

When I was conducting a particular experimental run, the REPLICATE element was set to continue from each replication for each experimental run in the case of multiple replications. In this case, I want my random numbers in the following replications to continue from the stream in the first replication so that different random samples are used in each replication. SIMAN does this by default.

Verification and validation of the simulation model have also been carried out, hence further satisfying the issue of validity of the model to represent the actual system. The standard procedure of ANOVA was applied to analyse the results. The simulation results were also reflected in the case when company and improvement had been achieved.

In this case, we might question the method SIMAN uses to generate the random number streams, but as John von Neumann famously pointed out that this is dealing with 'cooking recipes' for making digits, and it probably cannot be justified. SIMAN is a well-accepted simulation language that supports the ARENA simulation package (formally by Systems Modelling, now by Rockwell) developed and expanded by key researchers and practitioners in the field of simulation, including Dennis Pegden, Robert Shannon, Randall Sadowski, David Kelton[2] and Deborah Sadowski, and used by many researchers and practitioners. Generally, I am fairly confident with the tool.

Any simulation results are 'estimates', and in this case, they are particularly relevant to the case tested.

References

1 Pegden CD, Shannon RE and Sadowski RP (1995). *Introduction to Simulation Using SIMAN*, 2nd edition. McGraw-Hill: New York.

2 Kelton WD, Sadowski RP and Sadowski DA (1998). *Simulation with ARENA*. McGraw-Hill: New York.

University of Sheffield, UK   SCL Koh