The research design for this study has been chosen to be experimental (Matthews and Ross, 2010). As Saunders et al. (2009) write, experiments are usually conducted using simulated environments in laboratories. This is also true in the context of this research since it is not possible or practical to undertake projects in reality in order to answer the research question. Therefore, computer experiments are deployed for simulating the implementation of portfolios. The results of experiments are then compared with the probabilistic duration values of the same portfolios as achieved by Ghaffari and Emsley (2016) in their study on the boundary between good and bad multitasking. The experiments facilitate testing the following hypothesis:

Shorter buffer sizes can be accounted for by abolishing the ban on multitasking while maintaining a lower level of resource capacity.

The independent and dependent variables of experiments are depicted in Figure 1. Two software packages were used for the experiments: RanGen, a random project network generator that allows manipulation of more topological measures and resource characteristics than its alterna-
The main reason for choosing the CCPM software packages for both the best-known and long-established sines such as ProGen, ProGen/Max and middle values respectively and middle values (Demeulemeester et al., 2003)

al. are depicted in 

Table 1

are depicted in

Table 1

referred to in

Table 3

or even lower for portfolios with RC of 0.8 to 1.0, regarding the deterministic values of Table 3.

It should be noted that while 30% buffer sizes become valid from second level of multitasking for portfolio with RC of 0.9 and 1.0, this happens only from the third level of multitasking for portfolio with RC of 0.8. These reduced buffer sizes could not be applied to other portfolios that also experienced some released capacity after the introduction of multitasking (of RC of 0.4 to 0.6) because the released capacities were not sufficient to account for at least 10% shorter buffers which is the basis of precision considered by this study (less than 5% shorter buffers might be possible for some portfolios).

The implications of these data for the research question and hypothesis of this study will be discussed in the next section.

4. Discussion

The aim of this study was to investigate the effects of good and bad multitasking on buffer requirements of CCPM portfolios with the same resource capacities considered in the study conducted by Ghaffari and Emsley (2016). This aim invoked one research question and one hypothesis that are hereby addressed using the achieved results. How should time buffer sizes be adjusted according to the level of multitasking and resource capacity to avoid both over-protection and delay in CCPM portfolios?

Tables 3 and 4 address this question by providing the required data for drawing a comparison among different buffer sizes and simulated duration values. They show that after the introduction of two higher levels of multitasking and releasing some of the unused capacities as the result of over-protection can be accommodated for in portfolios with RC of 0.7 and higher, as explained in this section. This supports the hypothesis of this study mentioned in the methodology section above:

Shorter buffer sizes can be accounted for by abolishing the ban on multitasking while maintaining a lower level of resource capacity.

According to this hypothesis, as the resource capacity downsizes, shorter buffer sizes can be accounted for with allowing higher levels of multitasking. Therefore, based on the introduction of Tables 3 and 4, it can be suggested that with allowing multitasking of up to 3-tasks, a 40% buffer size is appropriate for resource availability of 100% (RC of 0.7).
6. Limitations and future research

The validity of results of this study is limited by the extent of effectiveness and capabilities of the software packages that were deployed, namely RanGen and ProChain Pipeline. The available alternatives to these packages and the rationale for choosing them were explained in the methodology section; however, it is certain that their selection over others would have a potential impact on the results. For example, ProChain Pipeline (the academic version) dictated that portfolios constitute four projects only and the critical chains and buffers were determined and placed based on its specific algorithms. In addition, the internal resource levelling algorithms and heuristics of ProChain Pipeline is different from any other software.

Another limitation of this study was the usage of generated data instead of real CCPM projects’ data. Although deployment of real data could improve the validity of the results through consisting many real-life events such as rework or change of resource capacity throughout portfolios, the controllable topological parameters of generated data enabled a more comprehensive research by including varieties of projects with different complexity and resource availability rates.

Considering what was accomplished in this research, a number of suggestions can be made for future research. Firstly, because of the choices made in selection of software packages, aspects of real environment such as rework and iterative work style were not taken into account in modelling and simulations that could be considered for future studies. Secondly, only human resources were considered in this research. This can be extended to a combination of human and non-human resources in future similar studies. Thirdly, with accumulation of historical data about CCPM projects and portfolios throughout time, real project data can be deployed in future studies instead of generated data.