The composition and size of the choice sets are a key for the correct estimation of and prediction by route choice models. While existing literature has posed a great deal of attention towards the generation of path choice sets for private transport problems, the same does not apply to public transport problems. This study proposes a timetable-based simulation method for generating path choice sets in a multimodal public transport network. Moreover, this study illustrates the feasibility of its implementation by applying the method to reproduce 5131 real-life trips in the Greater Copenhagen Area and to assess the choice set quality in a complex multimodal transport network. Results illustrate the applicability of the algorithm and the relevance of the utility specification chosen for the reproduction of real-life path choices. Moreover, results show that the level of stochasticity used in choice set generation should be high in order to provide stable parameter estimates when the choice sets are used for estimation regardless of the initial parameters for choice set generation. Last, results illustrate that adding heterogeneity across travellers should be required because coverage increases significantly, a relevant result considering that models are becoming more disaggregate in nature in real-life applications.