Blind source separation technique has emerged as a new tool in the area of manufacturing root cause analysis and variation reduction, with which major sources of variation can be identified blindly (i.e. without prior knowledge or information of the physical processes) from multivariate measurement data. One recent modified algorithm, Optimally Combined Blind Source Separation algorithm, combined different separation criteria so that mean square estimation error for all sources was minimized all at once. In this article, we present a sequential separation approach, at each stage of which the mean square estimation error of one source is minimized. The performance analysis reveals the proposed sequential blind source separation approach could achieve better accuracy than the optimal "all-at-once" approach.