ABSTRACT

With the advancement of health information technology, medical professionals have realized that patient information sharing is important. This can be achieved by utilizing health information exchange (HIE) networks. Network sustainability is one of the most serious challenges when building an HIE network. Joining the HIE network must be profitable for all prospective members; otherwise, the network will not be sustainable. This study aims to quantify the costs and benefits of the HIE network from the perspectives of healthcare providers (HCPs), payers, and HIE owner. The benefits of the HCP come from avoiding unnecessary activities, such as repeated visits and redundant healthcare procedures. Regarding the benefits of the payers, HIE helps insurance companies in reducing the costs of reimbursement. However, joining an HIE network is not free because members must pay a subscription fee to the HIE owner according to their subscription plans. Three subscription plans are considered in this research: per visit (PV), per look-up (PL) and per service (PS). In the PV plan, HCPs and payers pay the HIE owner for each patient visit. In the PL plan, HCPs and payers pay only for subset of the visits depending on the look-up rate. The PS plan is similar to the PL plan, with the exception that the look-up rate is the same as the percentage of avoided visits.

This research develops a multi-objective Mixed Integer Non-linear Programming (MINLP) model to optimize the benefits of all HIE agents and to ensure that the network is sustainable. The model involves three decision variables: whether to join the network, which plan to select, and the amounts of subscription fee of the selected plan. The model allows each member to join and leave the network over time. The members are also allowed to choose any subscription plans and switch between plans annually while joining the HIE network. The model is linearized and then solved in three phases using five problem instances, each involving three types of HCPs: small, medium, and large (based on the volume of patient visits). In phase I, the model is solved as a single-period single-objective optimization problem to maximize the benefits of HCPs, payers, and the HIE owner individually. A sensitivity analysis is conducted for the look-up rates of PV, PL, and PS plans, and the safety cushions of HCPs, payers, and the HIE owner. In phase II, the model is solved as a single-period multi-objective optimization problem using a weighted-sum approach. In phase III, the model is solved as a multi-period multi-objective optimization problem to investigate the behavior of the HIE network in the long run (five years). In phases II and III, various weights are experimented to determine the best set of weights that maximizes the benefits of all agents in the network. The results show that the maximum and minimum percentages of HCPs that joined the network are 80% and 40%, respectively. For the payers, the maximum and minimum percentages of joining are 100% and 0.0%, respectively. The optimal amounts of fee of the selected plans are always equal to their upper limits. Therefore, the HIE owner receives more income from the agents to cover the operating costs of the network. When the model is run for five years, it is noticed that the HIE network remains sustainable and profitable for all the agents. The sensitivity analysis shows that HCPs are more sensitive to the model parameters than the payers and HIE owner. The results of this study can help decision-makers understand the cash flow into and out of an HIE network and the dynamic behavior of the network in the long run. The provided quantitative measures for costs and benefits of HIE networks can encourage healthcare practitioners to use the HIE networks to share healthcare records.