Proactive and reactive planning for medical transportation

Context and problem description

- Decisions:
  - To assign the drivers and assistants to some vehicles (ambulance, taxi, light medical vehicle).
  - The crews can be modified during the day.
  - To reject some requests.
  - To dispatch the medical transportation requests to the vehicles.
  - To decide on the operating time of the workers.

- Constraints:
  - To serve the maximal number of requests.
  - To satisfy the time constraints for the requests.
  - The skills of the crew have to match with the request requirements.
  - Legal working rules on breaks and lunch breaks have to be satisfied.

Numerical results

- On the static problem.
  - Our heuristic outperforms the manual approach:
    - From 1 to 6.5 uncovered requests.
    - The global evaluation of the solutions is improved by a factor 2.
  - Our heuristic improves the best known solutions for some special cases with multiple trips and some variants of the dial-a-ride problem.
  - The average number of trips per worker is 1.3 and 5.0 on some large instances.

- On the dynamic problem.
  - Our approach outperforms two manual strategies in 93% of the simulated cases.
  - Using the proactive plan to initiate the dynamic process, improves the final solution from 3% to 14% depending on the context.

Solution framework

- A first proactive plan is built the day before.
  - It defines the beginning of the working period of some workers.
  - It fixes some service times in the planning.
  - Two approaches are applied to build the proactive plan:
    - The final objectives minimization.
    - To balance the workloads.
    - To unbalance the workloads, i.e., to keep some drivers available.

- During the day the plan is dynamically updated.
  - Deep modifications are allowed: If the move to the patient did not start, the current assignment can be modified.
  - The flexibility on the service times and the limits of the working periods are used to insert new requests.

A large neighborhood search combined with a local search is able to find good solutions to the static and the dynamic problems.

References

