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# Can autonomous agents lead to human-autonomy teaming? – A view into the field and implications for research and practice

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## Theoretical Background

Humans increasingly have to interact with automation in a wide variety of contexts. Technological advances in machine learning and artificial intelligence enable the further development of automation to autonomous agents that are able to deal with uncertainties, adapt their capacities to dynamic situations, and make intelligent decisions autonomously.[1,2,3] As a result, technology is no longer considered as a tool, but increasingly as a team member for humans.[1,4,5] Accordingly, the team and automation research are increasingly dedicated to the topic of human-autonomy teaming (HAT).

## Research Questions

Especially, a more in-depth analysis from an experts' point of view on HAT, considering different industries, has been missing so far. This study contributes to this gap by raising the following research questions:

- What is the current state of HAT in the field?
- Can, from the experts' point of view, autonomous agents function as team members for humans?
- What are the requirements for HAT so that automation can be used as effectively as possible in the sense of a team player for humans and are those in line with the scientific debate?

## Method

28 semi-structured interviews with the help of an interview guideline were held with experts from different industries and in various functions as well as from science between January and May 2020. The following frequencies result for the different fields:

- Science (6);
- Manufacturing (6);
- Rail Industry (5);
- Air Traffic Control (4);
- Maritime Industry (3);
- Nuclear Sector (2);
- Civil (2) & Military Aviation (2);
- Surgery (2);
- Medical Diagnosis (1);
- Intensive Care Medicine (1);
- Nursing (1);
- Logistics (1)

Only those experts were included who had at least five years of experience on the relevant topics ($M$ = 13.61, $SD$ = 9.51). The interviews were conducted via (video)telephony and lasted an average of 50 min ($SD$ = 13.08). They were analyzed according to the structuring qualitative content analysis by Mayring[6] using the software MAXQDA 18. We complement this study by an ongoing literature review.

## Results

The concept of HAT is hardly applied in the field as it comes with many (technological) challenges. We reveal an experts' disagreement on the **feasibility** of HAT in the field. While some consider HAT realizable and desirable, others deem it impossible or even reject it (Fig. 1). We identified **key aspects** for successful HAT and converted them into a model (Fig. 2). The results indicate that the topics discussed scientifically are also practically relevant.

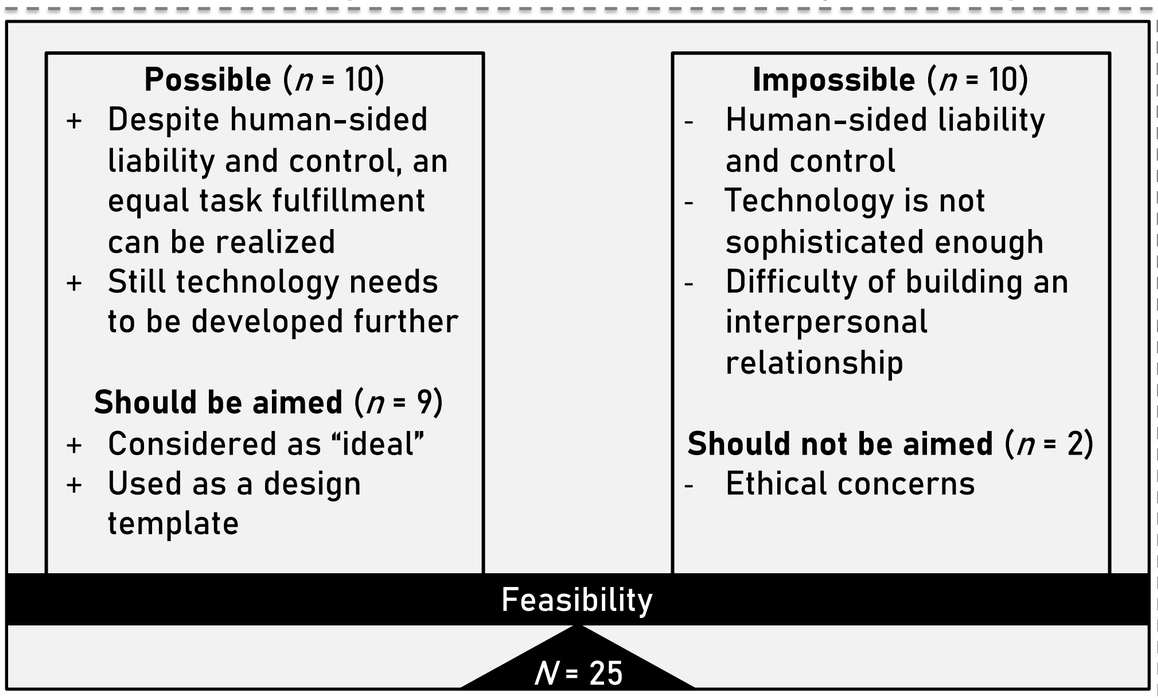


Fig. 1: Experts' responses regarding the feasibility of automation as an equal team player.

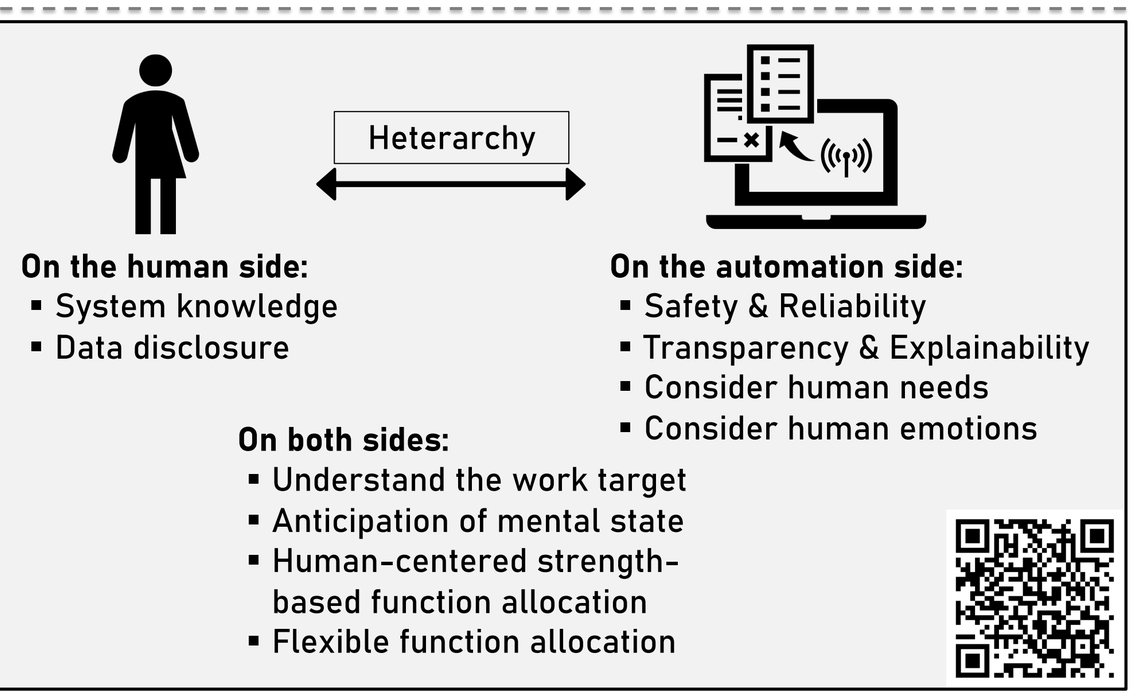


Fig. 2: Key aspects for successful HAT.

Scan here for definitions and quotes

## Discussion and future research needs

Today's technology is far from being able to meet the practical requirements for successful HAT, as postulated in the literature. The presented model can serve as a guide for future research and practitioners to *jointly* contribute to the successful implementation of HAT in the field. We identified future research needs from a practical perspective, which arise especially in the area of heterarchy, system knowledge, anticipation of mental states, flexible automation, and consideration of human needs. We, as a scientific community, seem to raise questions that are consistent with the concerns raised by practitioners. With this study we contributed to bring science and practice closer together which is, especially in the area of HAT, a key factor for success.

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