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Morphological Analysis for Design Science Research: The Case of Human-Drone Collaboration in Emergencies

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Abstract. Drones are becoming pervasive in private and professional settings. The engineering of human-drone collaboration poses unique challenges. Specifically, drones' distinctive capabilities yield a vast design space. Yet, the relevant guidance is scattered across literature such that an overview of various design dimensions is missing. This paper synthesizes adequate research and provides an overview of essential design dimensions in the form of a morphological box (MB) to support designers of drones for emergencies. Using this MB, practitioners and researchers become aware of design decisions they will have to make when designing drones or collaboration between drones and humans. It prevents fragmented or partial perspectives on drones design and provides a basis for structured, holistic design explorations. Using the case of drones, we discuss the potential of morphological analysis for design science research (DSR). New types of sociotechnical systems involve a vast, multidimensional design space, and singular studies frequently address domain or discipline-specific subsections of this space. We claim that morphological analysis supports a systematic exploration of the design space across disciplinary boundaries and might contribute towards a more transparent and traceable design of DSR artifacts.

Keywords: morphological analysis, morphological box, drones, unmanned aerial vehicles, multi-copters, emergency, literature review, sociotechnical systems

1 Introduction

The use of drones, both privately and in a professional setting, is steadily increasing. Human-piloted drones are used widely in crises and have proven to benefit emergency response scenarios. However, human-piloted drones also have considerable disadvantages in emergencies. They can easily lead to an information overload and a high workload for the pilots [2]. Recent advances and new autonomous features have enabled drones to function without human interference. Yet, the design of effective human-drone collaboration patterns poses further challenges to researchers and designers.

A drone, a multi-copter, or an unmanned aerial vehicle (UAV) is an aircraft designed to operate without an onboard pilot, and it does not carry passengers. A drone can be autonomous (controlled by an onboard computer) or wholly or partially remotely controlled by a human or an on-ground computer [60]. Especially autonomous drones, using contemporary AI, can take over monotonous, tedious, or challenging tasks from

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humans allowing them to focus on other tasks. Their broad applicability and autonomy make them adequate for application in emergencies like natural disasters. However, drones are restricted by the cognitive capabilities of the AI and physical limitations like their maximal payload or battery life. Thus, they can be most effectively applied when collaborating with humans [2].

Designing for human-drone collaboration is particularly challenging. Drones might possess the ability to act autonomously: from autonomously deciding on the trajectory of flight up to planning their actions [2]. However, drones' capabilities and limitations differ significantly from those of humans. They can reach positions previously unreachable to a human quickly while using its sensors (navigation systems, altimeters). Therefore, humans might struggle to make sense of the drone's actions or 'put themselves in the shoes' of a drone [21]. Collaboration without mutual understanding and shared meanings causes problems, primarily under time pressure [62]. Collective sensemaking and mutual understanding are particularly important in emergencies – high-risk organizations carefully engineer protocols and procedures for it [61, 62]. Accordingly, designing for human-drone collaboration in emergency situations goes beyond simply creating the technology: it requires a holistic and sociotechnical approach.

However, existing literature lacks a comprehensive perspective on interactions and collaborations between humans and drones. The emerging discourse focuses mainly on the technical aspects of the drones or, to a much lesser extent, the user interfaces for interacting with drones [2]. A structured overview of various dimensions in the design space is missing. Designers find themselves overwhelmed by the complexity and variety of decisions they need to take when engineering collaboration between humans and drones for emergency response. Instead of exploring the design space systematically, they might implicitly default on dominant patterns (e.g., use of singular drone equipped with multiple sensors leading to a heavy payload) rather than on alternatives (e.g., use of several cooperating drones each carrying a single sensor). This paper makes the first step towards a systematic overview of the relevant design dimensions addressed in different disciplines like computer science (CS), emergency management, or the law. The practitioners receive an overview of the relevant design aspects to be considered.

To identify those dimensions, the study employs morphological analysis (MA) based on recent articles from various disciplines. Whereas MA, leading to establishing the so-called morphological boxes or taxonomies, is frequently used in information systems (IS) research [15, 63], reflection on its usage for designing systems is only in its infancy [41]. To our best knowledge, MA's potentials and procedures for the DSR have not yet been studied. Using the case of human-drone collaboration, we propose and employ the morphological analysis for sociotechnical systems (MASS). We discuss how MASS taxonomies inform IS design while adhering to high rigor standards. We argue why a systematic description of a transdisciplinary design space forms an individual contribution and suggest how it might be used for bridging the creative gap in design.

Overall, the study has two contributions towards IS. First, it offers a nascent overview of the design space for human-drone collaboration based on transdisciplinary literature analysis. This taxonomy can benefit developers and design researchers involved in this growing application area. Second, it discusses the potential of using morphological analysis in DSR. It contributes towards the toolset associated with DSR.

2 Background

Consider crisis situations such as an avalanche: A drone or a team of drones could autonomously scan the area for survivors (e.g., using thermal imaging) and notify rescue units. It could provide exact geographic coordinates and pilot the units to the emergency scene. On-site, drones could quickly transport material between rescue units, collect information about the operation from above, providing specific, selected cues to the coordinator (e.g., detected rapid movements below the snow), or inform uninvolved individuals to stay off the scene. Completion of those tasks depends on successful collaboration with human stakeholders or other drones. However, a human-drone assemblage is a complex sociotechnical system. One way of dealing with this complexity is by decomposing it into its singular dimensions. It allows for finding a suitable configuration across the dimensions. In the following, we first summarize the discourse on human-drone collaboration and then propose a sociotechnical perspective.

2.1 Human-Drone Collaboration

Human-drone collaboration can be subsumed under the larger discourse on human-autonomy teaming [9, 40, 45] and machines as teammates [53, 54]. The articles follow mostly a conceptual approach and provide guidance regarding the design and work with autonomous team members. They yield frameworks referring to transparency, communication, authority, or situational awareness. Yet, they frequently assume a general notion of an agent [9, 45] or explicitly refer to conversational agents mimicking human abilities and communication [23, 53, 63]. This discourse induced major interest in the IS field. Yet, ambivalence towards differences between classes of digital agents (DA) has drawbacks. It abstracts from the dependency of successful collaboration on the ability to put oneself in the DA's place. Successful teams embrace empathizing and taking each other's perspectives as a core way to establish a common sense [24, 37, 62]. Some agents might be easier to empathize with than others. The more distinct an agent is from a human, the more difficult it gets to make assumptions about its behavior [21, 49]. It is essential in the case of drones that provide capabilities unavailable and sometimes hardly imaginable for humans. Consequently, the collaboration between humans and drones requires a specific approach different from, e.g., designing collaboration with conversational agents or agents without physical representation and capabilities.

However, most of the research on drones happens outside of IS. Accordingly, available meta-studies in CS focus on, for instance, architectural issues [14], path planning and navigation [38, 64], or control mechanisms [6]. Law studies review research on regulatory aspects [57]. Studies in other disciplines summarize application scenarios in specific domains like agriculture [18] or traffic management [32]. There are also recent reviews addressing the application of drones in crisis and emergency situations [28, 46, 56]. However, they focus on bibliometric analysis, description of envisioned or implemented uses of drones for specific tasks, and technical challenges. They do not attend to the agency of drones or the collaboration between humans and drones, framing drones as passive tools at humans' disposal. The studies point a designer to relevant literature, but they provide little support for designing human-drone collaboration.

2.2 A Sociotechnical View of Human-Drone Collaboration

The IS community has not yet established its own approach towards human-drone collaboration. Individual conference papers discuss the domain-specific application of drones in transportation [51, 59] and healthcare [33, 52]. They concentrate on the advantages and disadvantages of specific drone applications or elaborate on operations and business models in a defined context. A sociotechnical view on human-drone collaboration remains absent despite the sociotechnical perspective being considered the core axis of IS research [50]. We argue that given the tight interdependency between drones and human agents in most application areas, framing it as a sociotechnical system provides a sound foundation to analyze and engineer drones' applications.

The notion of sociotechnical systems has influenced IS research and practice for decades [19, 22, 50]. The workings of a sociotechnical system involve interaction between humans and technology. Individuals, collectives, and their relations framed by hierarchies, cultures, rituals, practices, or economies form the *social component* [36]. The technology, including human-made hardware, software, data, and techniques associated with them, forms the *technical component* [36, 50]. The social and technical components enter reciprocal, iterative, and complex *mutual interactions* in the process of joint optimization [50]. If successful, the interactions between the social and technical components impact the *context* by achieving instrumental objectives like work efficiency or profitability and humanistic objectives like wellbeing or job satisfaction [50]. The interactions between social and technical components are frequently complex and subject to mutual adaptations, such that one cannot predict the working of the whole sociotechnical system based on the performance of its single components [62]. We claim that this complexity increases when the technical component relies on non-deterministic autonomous technologies using artificial intelligence (AI): the relation between technical and social components can stabilize faster if the output of the technical component is predictable, allowing humans to establish mental models of its working. It gets harder if the technical component relies on probabilities, like in the case of agentic or (semi-)autonomous drones. Overall, human-drone collaboration can be framed as a complex sociotechnical system that requires a holistic, multidisciplinary approach.

MA helps deal with complex systems by identifying multiple dimensions of their working and explicating various combinations of their characteristics rather than dissecting them into individual components [48]. Originally proposed to investigate the complete set of relationships in non-quantifiable problem complexes, MA quickly became applied for the artifacts' development. IS applies MA to explicate technical dimensions of classes of systems [63], classify technological phenomena [44], or frame field results [16]. Only recently, the community started reflecting on the use of MA in design processes and IS research [41]. Yet, this reflection focuses on MA for designing technical artifacts rather than sociotechnical assemblages. We aim to explore design dimensions of a complex sociotechnical system at the example of human-drone collaboration. We, thus, ask the following research question: *What design dimensions describe the state-of-the-art collaboration between humans and drones in emergency situations?* We employ a multidisciplinary literature review, MA, and the structure of a sociotechnical system to systematize those dimensions and their characteristics.

3 Methodology

This section describes the process we applied to characterize the sociotechnical system' human-drone collaboration' as an object of engineering and design. Simultaneously, it systematically describes an MA-based method to explore the design space of a sociotechnical system systematically and rigorously regarding past research. First, we provide an abstract view of this method. Then, we describe the instantiation of this method for the study employed to answer the research question.

3.1 Morphological Analysis for Sociotechnical Systems (MASS)

MA was conceived as a method for discovery, invention, research, and construction with a specific focus on complex real-world phenomena and problems [65, 66]. It shall support the systematic exploration of a problem and relationships associated with this problem without defaulting on pre-assumptions or biases [65]. It is applicable to complex problem fields that are non-quantifiable, contain non-resolvable uncertainties, cannot be causally modeled or simulated, and require a judgment [48]. MA proposes a set of techniques, including the *morphological box* (MB) [66] also referred to as (morphological) taxonomy [35, 41, 43]. This technique particularly fits the goal of investigating a total set of configurations contained in a problem complex or the design space [47]. 'In the process, we build up a problem laboratory where we can generate alternative solutions depending on different hypothesized conditions. In a sense, we build a non-quantified input-output model, in which we can define independent and dependent variables, test certain conditions against others, and hypothesize relationships' [48].

The technique we propose sources at *the method of the MB* defined by Zwicky [66], *the MA-based process of collective creativity* by Ritchey [47, 48], and *steps for standalone descriptive literature reviews* by Templier and Paré [58]. Table 1 lists and describes the steps while referring to the individual methodological guidelines.

Table 1. MASS procedure. Steps 1 to 8 (green) deal with generating a MB. Steps 9 to 13 (blue) instruct how to employ the box to explore the design space.

Steps of the MASS procedure	Explanation and source of the guideline
1 Check **entry conditions**: - design space is non-quantifiable - contains uncertainties - cannot be causally modeled - requires a judgment	MA is dedicated to dealing with a 'mess', wicked problems which are complex, ill-defined, ambiguous, unstable. The goal of MA is to transfer the mess into dimensioned and structured problems to enable systematic exploration of the issue and the definition of a solution [48].
2 **Formulate a design problem** you want to address. A problem describes the gap between the status quo and the desired state. It might be concrete, provided by a project or case (e.g., a specific organizational issue), or abstract, based on literature or a vision of a system (e.g., exploration of capabilities needed to achieve X).	Zwicky [66] requires 'the problem which is to be solved must be exactly formulated.' The guidance for transparent literature review is more specific: 'define topic, formulate research question' for the literature review [58]. The defined problem should involve designing a sociotechnical system as one of the possible solutions.
3 Identify **potential and partial solutions** to the problem from the existing literature: a. run a systematic, traceable search in established databases using keywords or a set of seed articles b. if adequate, apply backward and forward search c. screen the articles based on inclusion and exclusion criteria, assess the quality and relevance of the articles	There exist multiple guidelines for conducting a transparent and traceable literature review. We rely on Templier and Paré's [52] indications for a descriptive review for their comprehensive treatment of this topic. Since MA aims to structure and describe a problem/design space, we refrain from suggesting higher-level reviews like critical reviews, meta-analyses, or realist reviews.

4 **Extract dimensions** of the solutions thematized in the literature. These include manipulated variables or differences in various designs, aspects presented as a challenge, or discussion of further developments. No need to collapse synonymous dimensions from various papers.	The MB method requires identifying parameters that might enter into the solution of the given problem [66]. Those are the primary parameters of the problem complex [48]. This overlaps with the step' extract data from studies' in the literature review [58].
5 For each dimension, define **a spectrum of potential values** based on the analyzed literature. Those values represent alternative solutions to singular issues related to each dimension. At this stage, there is no need to collapse dimensions or their values if they occur in several papers. Keep them all separate.	The MA requires that the taxonomy contains all of the solutions that might be given to a problem [66]. Various values in various dimensions represent those. All values in a dimension should be of the same type. They might be scales, nominals, idea packages, binary combinations, social or technical scenarios, etc. [48]
6 **Reduce and systematize** the morphological taxonomy: a. unify synonymous & overlapping dimensions, apply the union operation on dimensions when applicable b. collapse synonymous values within a dimension	A collective creative approach towards MA suggests a cross-consistency assessment which requires preprocessing of the values to repair vague concepts, synonymous meanings, or sources of confusion [48].
7 **Assure completeness** by checking finishing conditions: - each dimension's value appears in at least one paper - no new dimensions/values are added with new papers - dimensions and values do not repeat/are unique - every known dimension and value is in the box	MA requires a comprehensive coverage of the problem space [66]. We suggest using completion conditions proposed by Nickerson et al. [43] for taxonomy building. If a condition is not met, steps 3 to 6 should be repeated.
8 Use the sociotechnical perspective to **structure the identified dimensions**: context, social component, technical component, mutual interactions, and objectives. This step structures the MB and indicates unexplored gaps with potential innovative solutions.	None of the used guidance explicitly proposes this step. Yet, it might be helpful to employ some theoretical framing for conducting a literature review [58]. We claim that the sociotechnical system framework is adequate for structuring most of the design spaces in IS discipline.
Steps 1–8 yield a MB **synthesizing and reproducing the literature** coverage of the design space. Steps 9–13 use the box in a generative manner to **create new configurations** of a sociotechnical system.	
9 (optional) **Complement the MB** with: a. missing values in obviously incomplete dimensions (e.g., range-based dimension missing a middle range) b. dimensions specific for one's problem, project context, or the sociotechnical framing (see step 8).	Creative MA approaches [48] recommend workshops as a primary way to identify relevant dimensions. We identified them from the literature. Yet, literature might be incomplete. Systematically filling the gaps might yield innovations that outperform earlier systems.
10 **Find contradictions**, i.e., values that cannot co-exist or are incompatible within a single configuration. Document the contradictions or mark them directly in the MB. A cross-consistency matrix might be appropriate for larger MB.	Cross-consistency assessment reduces the set of possible solutions to those free of internal contradictions between values in different dimensions. A matrix with cells standing for each unique relationship between two values is proposed as an approach [47].
11 **Select relevant input values** that need to remain stable in one's design or exploration. They are a starting point for identifying dimensions and values configurations compatible with potential predefined conditions.	This allows for exploring the design space in a generative manner, i.e., yielding individual solutions and their configurations [47, 48]. Those configurations are combinations of single values from different dimensions.
12 **Evaluate all potential, non-contradictory configurations** compatible with one's input condition according to criteria relevant for one's project. Use results from the literature to identify which configurations were used in practice and how they performed.	Zwicky [66] suggests analyzing and evaluating solutions from the MB against purposes to be achieved. Evaluating key results and conclusions is also core for a descriptive literature review [58]. Yet not all possible configurations were studied before.
13 Informed by the literature, available resources, and project context, **identify design configurations to be explored further** (e.g., implemented and evaluated). This process might lead to discovering previously unattended dimensions or values for future research.	MA suggests selecting and implementing promising solutions [66]. An additional MA study might be necessary for problems occurring during implementation and application. Using results from literature might support the selection of best solutions and prevent repetitions [58].

3.2 Applying MASS to Human-Drone Collaboration

We aimed to identify the relevant design dimensions and their values for human-drone collaboration without selecting specific configurations. Accordingly, we followed steps 1 to 8 from Table 1. In the following, we attend to each step as we employed it:

1. As illustrated in the introduction, collaboration between drones and humans is not explored enough to allow for quantified or causal statements. Designing for this collaboration requires judgments concerning design directions under uncertainty.

2. The hypothetical design problem we address is the development of effective and adequate human-drone collaboration patterns for use in emergencies. We need to identify relevant design dimensions and their potential values to do so.

3a. We run a systematic search with two queries: *autonomous* AND *drone* AND *emergency* and *autonomous* AND *drone* AND *disaster* in titles and abstracts included in Elsevier Scopus since 2010. We selected 50 best-cited items for each query.

3b. We added 20 other items in the set based on the forward and backward search.

3c. We applied a set of selection criteria to retain articles which: (i) discuss a specific human-drone collaboration possibility, (ii) feature a semi or fully autonomous drone involved in the collaboration, (iii) feature an emergency application scenario except for policing and military contexts. Overall, we identified 53 relevant articles. The MA used all those papers, yet we refer to 20 exemplary papers that covered the design space to the most significant extent for presenting the results.

4., 5., 6. We extracted dimensions and values from the considered papers and then grouped by similarity. We collapsed synonymous dimensions and values, reducing the number of dimensions from 115 to 19. No dimensions were excluded. We introduced self-explanatory naming when appropriate.

7. We controlled the finishing conditions. Specifically, we assured that the taxonomy applies to all emergency situations presented in the source literature.

8. Finally, we grouped the dimensions in line with a sociotechnical system's structure.

4 Results

Table 2 presents the output of applying the above procedure to the design of human-drone collaboration for emergencies. Values and dimensions come solely from the literature study, such that the MB reflects previously studied aspects. Based on it, one could identify new configurations, see steps 9 to 13 from the procedure (cf. Table 1).

The analysis of the MB leads to several observations. First, the social components is barely covered in the literature. The only aspect considered for the social component is the skillset of the drone's operator. The analyzed papers barely attend to the social and organizational setting in which the collaboration happens and how internal developments within those components reflect the usage of drones. Second, studies do not explicitly, empirically attend to the humanistic or instrumental objectives, e.g., like proportionality or fairness of drone's use. Instead, they rely on the implicit assumption that emergencies are about saving human life, health, and possession in a most effective manner. Accordingly, drones are presented as means to enhance the effectiveness of the recovery missions. Consequently, the instrumental and humanistic objectives do not occur in the MB at all. Third, mutual interactions are studied by various structural aspects (number and type of agents, direction of communication). Variation in terms of mechanisms applied for distribution of roles or responsibilities and exchange of information, intentions, or desires were barely touched upon in the literature. However, the literature deals with the context and elaborates on the specifics of individual emergencies and technical requirements to enable an effective use of drones in those situations. The coverage reflects domains dealing with the topic: CS and emergency management.

Table 2. MB showing dimensions and characteristics relevant to designing collaborations between humans and drones with adequate sources.

	Dimensions	Values							Example Sources
Context	Emergency event	fire	drowning	avalanche	nuclear	chemical	multiple	unspecific	[1, 3–5, 7, 8, 11–13, 20, 30, 31, 34, 39, 42, 55]
Context	Drones' main task	search & rescue	surveillance	delivery	communication				
Context	Intervention time	pre-event	during event	post-event	independent				
Context	Operation duration	short (< 1h)	middle (< 12h)	long (> 12h)	unspecified				[10, 31, 42]
Context	Operation location	indoor	outdoor	flexible					[4, 7, 30, 42]
Social	Operator's skillset	trained	untrained						[1, 4, 5, 8, 31]
Mutual interactions	Number of drones	single drone	multiple drones						[1, 2, 7, 13, 42]
Mutual interactions	Interaction agents	humans and drones	a team of drones						[7, 8, 10, 12, 55]
Mutual interactions	Communication direction (general)	human → drone	drone → human	drone → drone	omnidirectional				[17, 26]
Mutual interactions	Communication with humans	unidirectional	bidirectional						[4, 8, 39, 55]
Mutual interactions	Information transfer	collect information	provide information	exchange information					[1, 2, 11, 17, 26]
Mutual interactions	Structure (humans:drones)	many:one	one:one	one:many	many:many				[1–3, 7, 8, 13, 31, 34, 55]
Technical component	Autonomy	semi-autonomous	fully autonomous	mixed mode					[2, 5, 13]
Technical component	Availability	off the shelf	specialized						[4, 30, 55]
Technical component	Flight range	short	middle	long	free				[3, 4, 10, 31]
Technical component	Payload	none	light	middle	heavy				[10, 12, 39]
Technical component	Battery runtime	short	middle	long					[3, 4, 30]
Technical component	Overall cost	low	medium	high					[3, 10, 13, 31, 34]
Technical component	Decision process	distributed	onboard decision system						[4, 7, 30, 31]

Overall, the MB provides insights into the focus of the existing literature. It points to research potentials. Additionally, it could be used for exploring the design space by generating new configurations of values and exploring their applicability. For instance, one could set on the case of an avalanche (as described in Section 2) and identify which configurations of human-drone collaboration were employed in this context or whether other possibilities might be more successful given previous evidence from other emergency events. This can inform design research projects in IS.

5 Discussion

The generated taxonomy and the proposed method have implications for DSR and IS. In the following, we, first, attend to the potentials of DSR for designing human-drone collaboration. Then, we discuss the proposed procedure as a transdisciplinary approach.

5.1 Design Science Research for Human-Drone Collaboration

Human-drone collaboration is a research area demanding attention because of the proliferation of the technology and the potential of drones in emergencies. Its specifics results from drones' physical abilities and limitations, which might be hard to imagine for humans, making the collaboration with drones harder than with other digital agents.

The analysis shows that the nature and mechanics of human-drone collaboration have not been researched much. We see two ways to fill this gap.

First, IS should revisit its own and adjacent discourses on human-machine teaming [9, 40, 45, 53, 54] to examine the applicability of the generic guidance for collaboration involving drones. We claim that some design principles developed for, e.g., conversational agents concerning transparency or explainability, can be adapted to drones, whereas those on, e.g., verbal conduct might be omitted or abstracted [23, 53, 63].

An exciting line of research might reflect the need to support mutual sensemaking of each other between humans and drones [21, 24, 37, 49, 62]. Humans can only hardly put themselves in a drone's 'shoes', thus making coordination of activities harder. Also, the current generation of drones lacks an understanding of human behavior, probably following the assumption that encountering humans up in the air is unlikely (as opposed to streets where self-driving cars frequently interact with uninvolved individuals). Designing ways to bridge this divide might be specifically crucial for the use of drones.

Second, technical researchers and designers developing drones should pair up with HCI or IS experts to include social and organizational aspects of drones' application. It is necessary to go beyond the technical focus [6, 32, 38, 46, 56, 64] and investigate the social characteristics of the application domains. Accordingly, the conducted literature review offers only a partial answer to the research question (*What design dimensions describe the state-of-the-art collaboration between humans and drones in emergency situations?*); the social dimensions yet need to be specified in a creative step of the MASS procedure. We invite the community to apply the MB to classify real projects.

5.2 MASS in Design Science Research

The sociotechnical perspective forms the axis of IS research [19, 22, 36, 50]. DSR is a paradigm for engineering and exploring the application of technological artifacts in social and organizational contexts [29]. What emerges from DSR projects are sociotechnical systems designed to support humanistic and instrumental objectives. DSR has positioned literature review as a relevant source for definitions of problems and theoretical underpinnings of the solutions [29]. However, design space exploration has been frequently seen as subject to creative and abductive processes [25, 27]. Recent considerations on MA suggest its use for generating design principles, i.e., prescriptive design knowledge [41], or taxonomizing design research outputs [35, 43]. The original purpose of MA is to explore possible relationships in a complex system [48, 65, 66] and multi-dimensional space [15]. This potential of MA fades away in IS despite its potential for understanding the transdisciplinary nature of design endeavors.

This paper outlines a technique that combines MA [47] and the MB technique [66] with a systematic literature study [58]. This technique helps (1) get a systematic overview of research addressing a related problem, (2) identify design decisions they will have to make during development, (3) select the most promising design ideas for each dimension based on past research, (4) spot untouched or underestimated aspects which might be the ultimate gamechanger for the overall performance. The sociotechnical framing calls researchers' attention to all equally important components. The procedure helps approach the creative gap systematically across disciplinary lines.

6 Conclusion

This article attends to human-drone collaboration in emergencies according to the proposed MASS technique. It indicates the need to explore the social aspects of this collaboration and to explicate the objectives of applying drones in emergency situations. This insight offers new areas of multidisciplinary inquiry for design and IS researchers, e.g., about multimodal platforms or swarming risks. It also informs practitioners on what relevant aspects have been addressed in the literature for the development of real-world applications. Additionally, the described literature-supported procedure can be replicated to explore design space for solving other complex, sociotechnical problems studied across disciplines. The proposed MB can be strengthened by considering a broader literature basis and real-world, industry applications to avoid publication bias.

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