Introduction

Space: Description and geography of Heidelberg and Rhine-Neckar district

Heidelberg is a southwestern German university city with ~160,000 inhabitants. It is an affluent economic area surrounded by the Rhine-Neckar district with a population of ~550,000. Further to the East lies the more rural Neckar-Odenwald district where ~140,000 inhabitants live (Figure 2).

Heidelberg had three vulnerable spots in its critical infrastructure that were susceptible to COVID-19. These included hospitals (Figure 3) such as the University Hospital which is one of the biggest and most important in Germany with 80,000 treated inpatients and more than 1 million out-

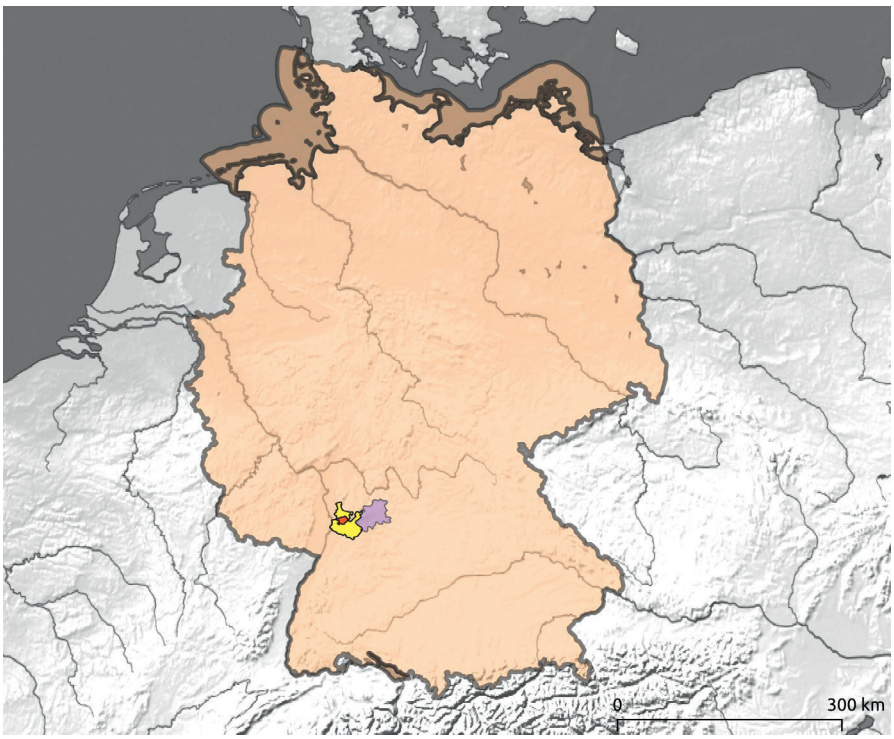

Figure 2. Geographic situation of Heidelberg (in red) and the Rhine-Neckar district (in yellow) within Germany. The neighboring Neckar-Odenwald district is shown in purple

Image credit: This map was created with QGIS [76] using Natural Earth data [63].

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patients per year [104]. There were several smaller hospitals in town (N = 9) and the surrounding districts Rhine-Neckar, and (N = 5) Neckar-Odenwald (N = 4) [92]. The nursing homes for the frail and elderly were at elevated risk of lethal disease courses of COVID-19. Heidelberg hosted a refugee center with a capacity of up to 2000 people which served as an institution of first and urgent admissions for incoming refugees and migrants [4].

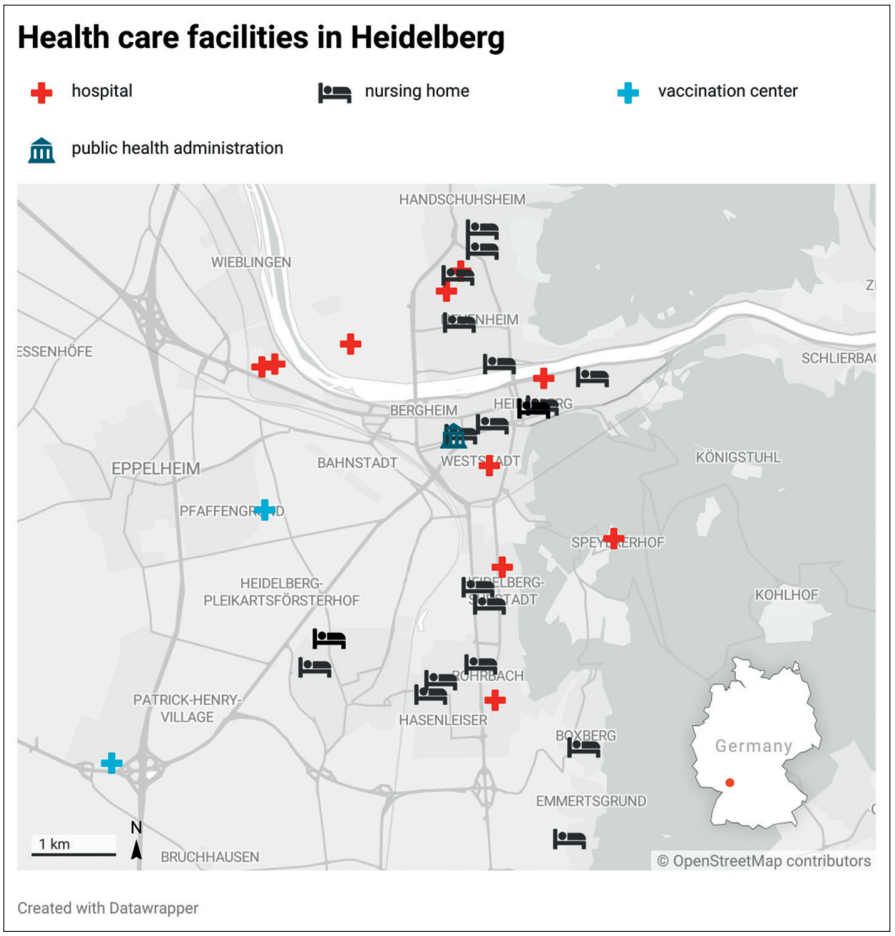

Figure 3. Health care facilities in Heidelberg

Image credit: Datawrapper [25] and OpenStreetMap [68]

Time: The great COVID-19 pandemic

COVID-19 (coronavirus disease 2019) is a respiratory disease with multisystemic manifestations due to an infection from the novel coronavirus which is also known as SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2). By 10 March 2023 (the day Johns Hopkins University has stopped collecting data), 676,609,955 cases and 6,881,955 deaths were reported globally [50]. A global overview over the timeline of major events in Heidelberg, Germany, during the COVID-19 pandemic is shown in Figure 4. First cases of COVID 19 in Heidelberg, Germany were reported on 27 February

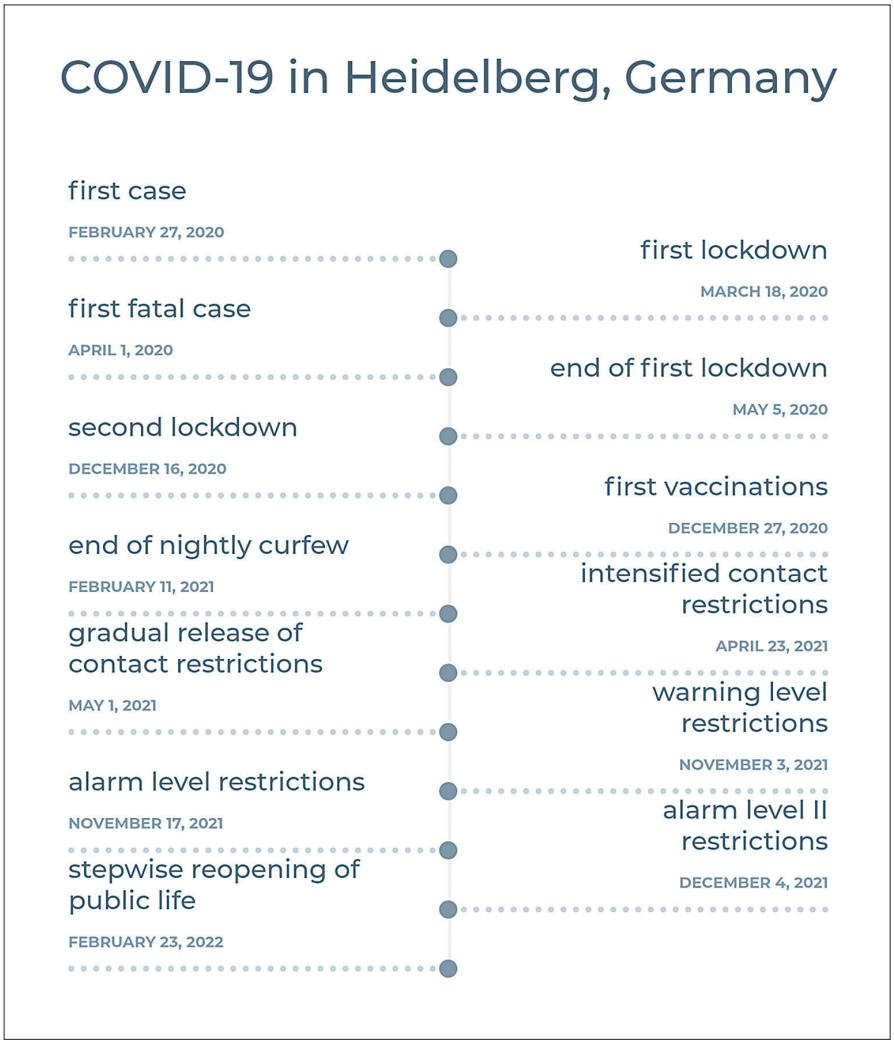

Figure 4. Timeline of important events during COVID-19 in Heidelberg

Image credit: This figure was created with Free Timeline Maker [1]

2020 [14]. On 13 March 2020, mass gatherings events were prohibited by the German Federal government, on 16 March 2020, schools closed and on 17 March 2020, shops closed, and public life went into a lockdown that ended with reopening in May 2020 [14]. The first death of a patient with COVID-19 in Heidelberg occurred on 01 April 2020 [14]. Due to an increase in new cases after the summer and fall 2020, a nightly curfew was imposed by the state government of Baden-Württemberg on 12 December 2020, and a second nation-wide lockdown started in Germany on 16 December 2020 [14]. First vaccinations against SARS-CoV-2 in Heidelberg were administered on 27 December 2020 at the central vaccination center under the direction of Christoph Schulze, MD. This important milestone started the vaccination campaign which was subsequently expanded [14, 90]. The nightly curfew in Heidelberg ended on 11 February 2021 [14]. Due to rising incidences, above 100 cases/100,000 inhabitants, contact restrictions were intensified on 23 April 2021 and gradually released after 01 May 2021 [15]. Increasing surges of patients with COVID-19 on intensive care units in the state resulted in further step-wise aggravations of contact restrictions beginning with the 'warning level' (defined by the decree of the state government) on 03 November 2021, the 'alarm level' on 17 November 2021, and the 'alarm-level II' on 04 December 2021 [16–18]. On 23 February 2022, the state government of Baden-Württemberg adjusted the corona rules which allowed a step-wise opening of public life again [19].

The spectrum of predominant SARS-CoV-2 infections within the population shifted over time from virus wildtype over alpha, delta, and omicron virus variants with a changing pattern of contagiousness, disease severity, and immune escape from available vaccines [83].

The epidemiological course of COVID-19 (new infections and deaths) in Heidelberg and Rhine-Neckar districts are summarized in Figures 5–8.

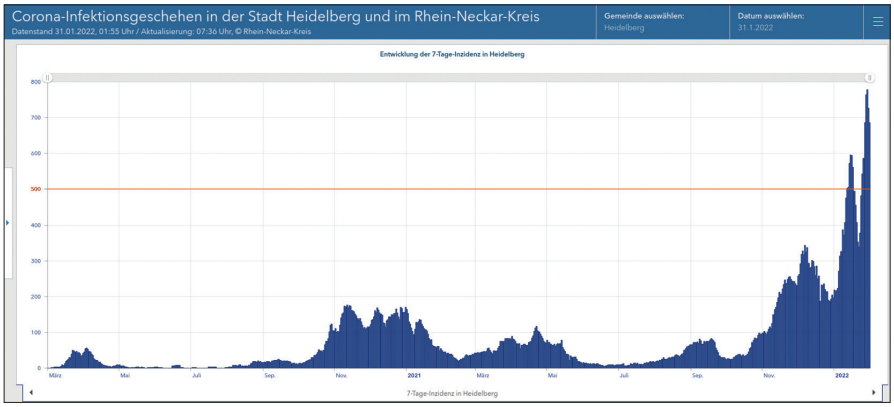

Figure 5. COVID-19 in ***Heidelberg: 7-day incidences*** (new cases)

Image credit: Corona dashboard Public Health Service Heidelberg/Rhine-Neckar [75]

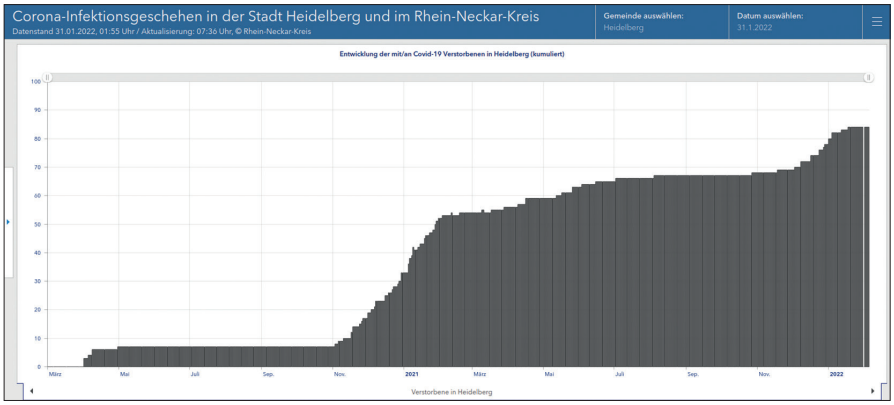

Figure 6. COVID-19 in ***Heidelberg: number of deaths*** (cumulative)

Image credit: Corona dashboard Public Health Service Heidelberg/Rhine-Neckar [75]

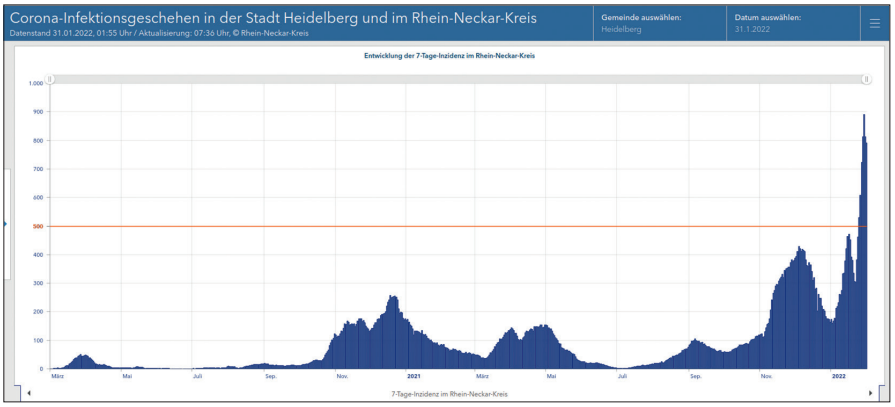

Figure 7. COVID-19 in ***Rhine-Neckar district: 7-day incidences*** (new cases)

Image credit: Corona dashboard Public Health Service Heidelberg/Rhine-Neckar [75]

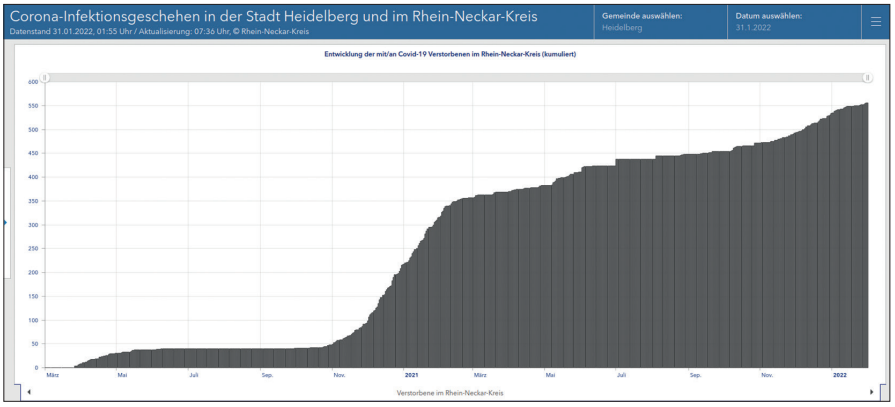

Figure 8. COVID-19 in ***Rhine-Neckar district: number of deaths*** (cumulative)

Image credit: Corona dashboard Public Health Service Heidelberg/Rhine-Neckar [75]

Knowns & Unknowns: Federal pandemic risk analysis of 2012

In 2012, the Federal Government of Germany conducted an insightful but nevertheless not very widely known risk analysis on a potential SARS virus pandemic which was published in 2013 [39, 96]. The likelihood of occurrence of a SARS pandemic was estimated as "conditionally probable — an event that statistically usually occurs once in a period of 100 to 1,000 years" [39, 96]. Considerable adverse consequences of such a pandemic were estimated with substantial impact on humans, the economy, as well as the immaterial sector which includes public safety, politics, and the psycho-social area [39, 96]. Of interest, the report recommended anticipatory medical preparedness by stating that "to date, there are no guidelines on how to deal with a mass influx of infected people during a pandemic. This problem requires complex medical, but also ethical considerations, and should preferably not be addressed only once a particular crisis occurs." [39 page 65]. In addition, the authors had anticipated substantial communication issues that later became indeed known as the COVID-19 "infodemic" [78].

The report recommended that administrative crisis staff teams would take over leadership and coordination of pandemic management, and that anticipatory assessment of the situation and consecutive planning would be aligned among players involved, although without providing detailed operational instructions [39]. Therefore, affected teams on the ground would probably act in a primarily self-organizational manner, at least in the beginning of the disaster response. In order to help prioritizing and structuring organizational and institutional functioning under pandemic conditions, the German Federal Office of Civil Protection and Disaster Relief had made a pandemic planning manual available, the first edition being published in 2008. This planning manual included links to other international, federal, and state level pandemic plans [42].

Circumstances: A mission in a VUCA setting

The COVID-19 pandemic in which this CIMIC mission took place, was a challenging situation characterized by volatility, uncertainty, complexity, and ambiguity, the phenomena of the so-called VUCA-world which are common in certain contexts of medicine or disaster situations [2, 33, 58, 65, 67, 90, 93, 97, 98, 109]. VUCA environments are extremely dynamic, yet turbulent, and can lead to inaction and paralysis if leaders are overwhelmed (Figure 9). In order to master VUCA challenges successfully,

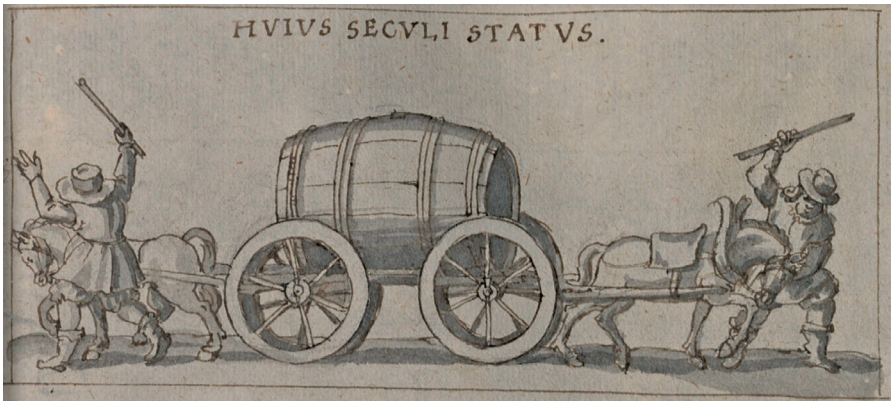

Figure 9. Highly energized paralysis and focused ambiguity has not been unknown to human psychology in history: "The state of this epoch", Southern Germany, 17th century [94]

"leaders need to 'see around corners'—to see something significant about the future that others don't see", and step up and take appropriate action [13]. The VUCA concept was influential in military thinking after the Cold War responding to the difficulty of outlining future environmental conditions [5, 13]. Each VUCA factor describes a particular aspect of the turbulence. As such, "volatility" implies frequent and unpredictable changes, "uncertainty" relates to the absence of knowledge as to whether an event will result in a meaningful change, "complexity" defines the presence of an interconnected and convoluted network of information and procedures, and "ambiguity" stands for the inability to understand cause and effect [7].

We have previously addressed and analyzed VUCA phenomena during COVID-19 in Heidelberg, Germany, in the context of the vaccination roll out campaign [90].

Framework: CIMIC in disasters worldwide and in Germany

The cookie, the truck, and the bridge—types of military assistance

In humanitarian actions or disaster relief situations, the United Nations distinguishes three types of military assistance: 1) direct assistance, 2) indirect assistance, or 3) infrastructure support [79]. Table 1 provides an overview of these three concepts and further elaborations on details and examples.

Table 1. Types of military assistance according to the United Nations Civil-Military-Coordination Field Handbook [79, 103]

Symbol		Type of assistance	Definition [103]
"The cookie"		Direct assistance	"Face-to-face distribution of goods and services"
"The truck"		Indirect assistance	"At least one step removed from the population—transporting relief goods, building camps and shelters, providing water sources, clearing mines and ordnance, etc."
"The bridge"		Infrastructure support	"General services that facilitate relief, but are not necessarily visible to, or solely for, the benefit of the affected population—repairing infrastructure, operating airfields, providing weather info, ensuring access to communications networks, etc."

Image credit: this table was designed using freely available resources from Flaticon [31]

Main sectors of humanitarian action and disaster relief operations—the UN cluster approach

When thinking about disaster management, it is of utmost importance to have a fundamental understanding about the basic needs of the potentially afflicted population including the vulnerable [10, 79, 82]. The UN-cluster approach provides a helpful overview and orientation about main sectors of humanitarian action and disaster relief. The following functional areas are considered: camp management, early recovery, children and education, emergency telecommunications, food security, health, logistics, nutrition, protection, shelter, WASH (water, sanitation, hygiene) [79, 101].

Respecting the humanitarian mindset is a foundation for successful cooperation with civilian partners

The UN recognizes that the military's specific capabilities and capacities are a valuable asset in humanitarian actions which includes disaster management [102].When wanting to work successfully together with a non-governmental or humanitarian organization in a disaster relief mission, it is of utmost importance to both medical and non-medical military CIMIC officers to take into account the humanitarian principles—Humanity, Neutrality, Impartiality, and Operational Independence—that guide these organizations, because they provide the fundamental principles for their members' cultural and social mindsets [102, 103]. From a UN perspective, the framework for CIMIC-relationships between the military and civilian humanitarian organizations is determined by two key considerations: is the situation 1) a natural, technological, or environmental emergency in times of peace assuming a stable government and the state providing for security, or b) is the emergency situation complex, i.e., military and other armed actors are or are perceived as party to the conflict and thus humanitarian actors would avoid any association with military actors and minimize their interaction? [103] In peacetime, humanitarian actors would seek a *cooperative* approach to civil-military interaction, while in complex emergency situations with direct involvement of the military in the conflict, they would rather choose a *co-existent,* i.e., a more distant and indirect, less visible relationship with military actors in disaster relief [103]. As the COVID-19 crisis in management Germany occurred in a peace time setting, direct civilian-military information exchange and even direct military assistance to the population—within the constitutional framework under civilian leadership—would not pose any issue to NGO's and humanitarian organizations [79]. A dialogue between military and humanitarian actors is considered essential and key elements of humanitarian civil-military

interaction includes information sharing, task division and joint planning [79, 102].

The constitutional basis for domestic CIMIC in Germany in disaster relief situations

Exposures to heat and cold, storms, trauma, chemicals, water, and infectious agents were mechanisms of injury in disasters that struck Germany in the past [10, 82]. The legal framework for domestic subsidiary CIMIC in disaster management in Germany is set by the Constitution, also known as "Basic Law". Specifically, article 35 defines mutual legal and administrative assistance between federal and state ("Land") authorities, the military being a federal authority. In addition, the legal framework of assistance during disasters—which includes assistance by the Federal Armed Forces "in order to respond to a grave accident or a natural disaster"—is defined in article 35 [41].

Operationalization of subsidiary domestic CIMIC support in disaster management

Unless there is an immediate emergency threatening lives, health, the environment, or property requiring urgent intervention, the domestic military support in disaster relief in Germany is subsidiary [40, 43, 95]. Usually, a civil partner would approach a CIMIC liaison command requesting a specific capability intended to achieve a specific disaster relieving effect [37]. A conceptually excellent didactic example for capabilities relevant to disaster relief is the inventory of deployment options of the civilian German Federal Agency for Technical Relief [36]. Military CIMIC liaison teams have both general military and medical expertise embedded in a comprehensive civilian network, and are available on the local, district, or Federal state level, mirroring their administrative civilian counterparts within the Federal structure of Germany. This domestic territorial network was led by the Command for Territorial Tasks in Potsdam, Germany, the medical side reported separately into the Operational Medical Support Command in Weißenfels, Germany [11, 38].

Rationale and goals for this research project

The extent and intensity of the COVID-19 crisis was significant worldwide. The corona disaster relief support was the largest subsidiary mission of the German Federal Armed Forces in their history. The shared challenges to the disaster management community were considerable worldwide as well as in the region of Heidelberg, Germany, due to the dynamics and complexity of situational developments [90].

Within the constitutional and legal framework, the civilian disaster relief in Heidelberg/Rhine-Neckar was supported by the German Federal Armed Forces. This cooperation with the various civil protection organizations was remarkably close, so that there were excellent opportunities for mutual learning, especially in the aftermath, in the sense of a "learning organization". The topic of crisis management is of foremost importance, strengthening the overall societal resilience to cope with crises and disasters (e.g., pandemics, refugee movements, disruption of energy supply, extreme weather, etc.), and will play an increasingly vital role in the future [10, 82].

A structured scientific analysis of the operational experiences of the COVID-19 disaster relief in Heidelberg/Rhine-Neckar, especially from a civil-military perspective, has not been done so far. This gap is now to be closed by the present study.

Research question

The research question of the study was **"what lessons have been learned from the civil-military cooperation in Heidelberg/Rhine-Neckar during the COVID-19 pandemic and what needs to be done to be better prepared for future disasters?"** This overarching research question was iteratively approached in three steps as explained further below.

We expected the results of this research to provide a deep expert insight into COVID-19 disaster preparedness at the local level. Flanked by comparison with published experiences at the global level [79], we hope that these lessons learned would contribute to sustainable strengthening local crisis resilience in the future.

Content and structure: Three modules of this work and their objectives

This work is divided into three modules representing a local and personal stakeholder level, as shown and further explained in Table 2.

Table 2. Modular levels of this project, representing a local and personal stakeholder analysis ascertained through a mixed-message approach, focusing on (1) mission goals and means, (2) mission impact, and (3) lessons learned for better preparedness and better future disaster resilience

Modular level	Focus questions	Methods
(1) Civil-military disaster relief support to Heidelberg during the COVID-19 crisis (mission goals and means)	What was done in Heidelberg/Rhine-Neckar?	Autoethnographic qualitative, empiric-observational analysis
(2) From civilian capability gaps towards societal resilience (mission impact)	What impact did the Heidelberg/Rhine-Neckar disaster relief mission have?	Structured interview with key stakeholders of the local disaster relief community
(3) From lessons learned towards better future disaster preparedness (resilience)	How well are we prepared for future catastrophes after lessons learned from corona and what must be done to close this gap?	Structured interview with key stakeholders of the local disaster relief community