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Transition**

Master's Degree in Disaster and Health Crisis Management

MASTER'S THESIS

**The role of the disaster manager within the healthcare system:
transversal competencies, training, and inter - institutional
coordination**

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“...non demordete mai dalle vostre idee. Se ne siete convinti, mantenetele fino all’ultimo. Devo citare Julien Benda: che le vostre risposte siano sì, no. E soprattutto non cercate di spiegare il sì e di spiegare il no. Perché ogni spiegazione è già un compromesso...”

“...never waver in your convictions. If you are convinced of them, hold fast to them to the very end. I must quote Julien Benda: let your answers be ‘yes’ or ‘no.’ And above all, do not try to explain the ‘yes’ or the ‘no.’ For every explanation is already a compromise...”

(A. Camilleri)

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Abstract

The increasing complexity of emergencies and disasters requires healthcare systems to develop planning, coordination, and adaptive capacities under conditions characterised by uncertainty, time pressure, and potential imbalances between healthcare needs and available resources. In this context, healthcare Disaster Management takes on an interdisciplinary and inter-organisational dimension, in which clinical, organisational, decision-making, and technological competencies must be integrated across the different phases of the disaster cycle.

This thesis analyses the role of the Healthcare Disaster Manager, starting from the difficulty of identifying in the literature a clearly defined and standardised profile in terms of functions, competencies, training, and organisational positioning. The research question guiding this work was therefore: what characteristics, competencies, and functions can contribute to defining the Disaster Manager in the healthcare setting, and what role can this figure assume within emergency and disaster preparedness and response systems? The aim is not to propose a new profession a priori, but rather to identify elements in the literature and in key institutional references that may help define its potential role as an integrating function across healthcare, organisational, and inter-institutional dimensions.

The study was conducted through a structured narrative review, primarily based on searches of the PubMed database and supplemented by literature collected during the university programme, as well as by the analysis of frameworks, guidelines, standards, regulatory documents, and national and international institutional publications relevant to healthcare Disaster Management. The analysis considered professional, cognitive, and non-technical competencies; training and assessment processes; tools supporting planning and decision-making; and selected applied contexts of healthcare emergency management.

The findings reveal a heterogeneous landscape in terms of competency profiles, training pathways, and assessment systems, preventing the identification of a single, universally standardised healthcare professional profile. Nevertheless, several recurring elements emerge, including planning, coordination, resource and information-flow management, Situational Awareness, Decision Making, leadership, and non-technical skills. Structured training, simulation, and operational experience appear to be complementary components in the development of these capabilities, while competency assessment and the analysis of previous experiences contribute to their maintenance and to organisational improvement.

The analysis also highlights the contribution of information-based and quantitative tools to preparedness and response. GIS, digital platforms, decision-support systems, predictive models, and operational indicators can enhance the ability to interpret evolving scenarios and deploy resources effectively, provided that they are integrated with reliable data, organisational procedures, and professional judgement. The case of La Notte della Taranta provides a concrete example of how historical data and quantitative models can be used in healthcare planning for a Mass Gathering Event, while CBRNe and USAR scenarios highlight the need to integrate tools, procedures, and specialised expertise within shared coordination structures.

Overall, the Healthcare Disaster Manager can be interpreted as a cross-functional role or function undergoing progressive professionalisation, aimed at integrating planning, preparedness, resources, information, and the different components of emergency

response, without replacing existing specialist responsibilities. As a potential organisational development, this thesis proposes an ordinary placement as a staff function providing strategic support to Healthcare Management, distinct from the functional position assumed during an emergency, when the Disaster Manager should operate within the activated command and coordination systems without creating parallel structures. In the future, this function could also be developed through territorial and regional organisational models, to be assessed according to the characteristics of individual healthcare systems.

The professionalisation of the Healthcare Disaster Manager therefore requires not only the definition and assessment of competencies, but also greater clarity regarding mandate, training, responsibilities, and organisational positioning. Its potential added value lies primarily in its ability to act as an integrating link between different professionals and organisations, contributing to the development of healthcare systems that are better prepared, better coordinated, and more capable of learning from experience.

Keywords: Healthcare Disaster Management, Disaster Manager, preparedness, Situational Awareness, Decision Making, competencies, inter-institutional coordination, decision-support systems, resilience.

Chapter 1: The Role of the Disaster Manager in the Modern Healthcare System

1.1 Evolution of Disaster Medicine: From a Reactive Paradigm to Proactive Governance

Disaster medicine is a multidisciplinary discipline that studies the effects of disasters on population health and develops organisational models aimed at ensuring an effective healthcare response in situations where healthcare needs temporarily exceed available resources [1,2]. Although it shares many principles with emergency and acute care medicine, it differs in its approach, which focuses not on the individual patient but on the management of the entire healthcare system under crisis conditions, integrating clinical, organisational, epidemiological, logistical, and public health competencies [3,2].

The development of the discipline has been characterised by a profound conceptual evolution. Until the second half of the twentieth century, disaster management was predominantly focused on post-event relief activities, following a reactive model that prioritised the mobilisation of available resources once an emergency had occurred. From this perspective, the success of an intervention was assessed primarily in terms of the speed and effectiveness of response operations, while preventive planning activities and the systematic analysis of risk factors were less developed [4,5].

Experience gained from major natural disasters, industrial accidents, technological emergencies, and terrorist events progressively highlighted the limitations of this approach. Retrospective analysis of these events demonstrated that the severity of their consequences depends not only on the magnitude of the event itself, but also on the level of institutional preparedness, the vulnerability of the affected area, and the capacity for coordination among the different components involved in emergency management [4,5]. This awareness contributed to moving beyond an exclusively reactive paradigm and to the emergence of a broader perspective focused on risk reduction and strengthening the response capacity of healthcare systems [4,3].

A major contribution to this shift has been made by international Disaster Risk Reduction (DRR) policies, developed within the framework of the United Nations and consolidated through the adoption of the Sendai Framework for Disaster Risk Reduction 2015–2030 [4]. The Framework proposes a model in which disasters are not interpreted as inevitable events, but rather as the result of the interaction between potentially harmful phenomena and pre-existing vulnerabilities [4,5]. From this perspective, risk reduction requires a coordinated set of activities involving analysis, planning, prevention, and preparedness, which must be systematically integrated into public policies and healthcare systems [4].

Consistent with this approach, the World Health Organization has developed the Health Emergency and Disaster Risk Management (Health EDRM) framework, which places health protection within a comprehensive risk management strategy [3,2]. The model promotes an integrated approach involving healthcare institutions, civil protection authorities, the scientific community, and public administrations, recognising that emergency management is a continuous process rather than an activity limited to the immediate post-event phase [3].

The evolution of disaster medicine therefore reflects a paradigm shift: from a discipline primarily focused on operational response to a scientific field dedicated to healthcare risk governance [4,3,2]. This transformation has progressively broadened the scope of

the discipline, placing greater emphasis on planning, inter-institutional coordination, the use of scientific evidence, and the adoption of organisational models capable of ensuring a structured response even in highly complex scenarios [3,2,5].

Within this evolving context, there is an increasing need for professionals capable of translating the principles of risk governance into organisational and decision-making processes. Among these, the Healthcare Disaster Manager is emerging as a key actor in integrating the planning, organisation, and coordination of emergency management activities.

1.2 The Healthcare Disaster Manager: Definition, Role and Areas of Competence

The evolution of disaster medicine towards an approach increasingly focused on integrated risk management has progressively broadened attention from event response alone to the need to integrate prevention, preparedness, planning, coordination, and recovery. This approach is consistent with the Health Emergency and Disaster Risk Management (Health EDRM) paradigm promoted by the World Health Organization, which considers the management of health emergencies within a systemic and multisectoral process [3].

Within this framework, the Healthcare Disaster Manager can be understood not as a replacement for the specialists involved in emergency response, but as a potential integrating function among the different healthcare, organisational, and institutional components involved in emergency management. International literature has progressively identified common competencies required by professionals involved in disaster medicine and healthcare response, including preparedness, planning, communication, coordination, and resource management skills [6–8,10]. However, available reviews reveal significant heterogeneity among the proposed models and do not allow the identification of a single, universally standardised professional profile corresponding to the designation of Healthcare Disaster Manager [6,8].

The distinctive nature of this role can therefore be primarily attributed to the ability to connect different competencies and functions within a complex system, translating the principles of risk management into organisational processes applicable to the healthcare setting. Its role may include participation in emergency planning, support for organisational preparedness, coordination of resources and information flows, and liaison among the different stakeholders involved. More recent literature focusing on medical disaster responders also confirms the importance of non-technical skills in disaster response settings, further reinforcing the need to integrate technical, cognitive, and organisational capabilities [71].

This cross-functional dimension becomes particularly relevant when an emergency requires the simultaneous involvement of hospitals, community-based healthcare services, emergency medical systems, civil protection structures, technical rescue services, and other organisations. In the Italian context, the criteria governing the organisation of healthcare relief during disasters place the healthcare response within a framework requiring coordination among multiple components [16]. Similarly, international emergency management models emphasise the importance of clearly defined command and coordination structures, shared terminology, and interoperability among different organisations [17].

From this perspective, the Healthcare Disaster Manager can be interpreted as a connecting node within a network, rather than as a figure intended to centralise operational responsibilities. The contribution of this role lies in facilitating the integration of information, resources, professional expertise, and different decision-making levels, while maintaining the distinct technical and specialist responsibilities of the various components involved in the response. This approach is also consistent with international coordination systems applied to complex scenarios, in which the standardisation of information processes and coordination mechanisms among organisations represents an essential element of interoperability [67,68].

At the organisational level, this thesis proposes considering the Healthcare Disaster Manager as a potential staff function providing strategic support to Healthcare Management, rather than as a role hierarchically superior to individual departments. Such a configuration could be consistent with the cross-functional nature of Disaster Management, allowing planning, preparedness, training, and exercises to be coordinated across the different components of the healthcare organisation. However, this organisational positioning should be understood as a proposal derived from the synthesis developed in this thesis, rather than as a professional model that has already been formally established or uniformly adopted within the Italian healthcare system.

It is also important to distinguish the ordinary organisational position from the function performed during an emergency. During the preparedness phase, the Disaster Manager could contribute to planning, training, exercises, and plan evaluation; during the response phase, however, the role should be integrated consistently within the command and coordination system activated for the specific event. The NIMS, for example, highlights the importance of clearly defined organisational structures and shared coordination mechanisms in the management of complex incidents [17]. The Disaster Manager should therefore not establish a parallel chain of command, but should be functionally integrated into existing systems, contributing to coordination among the healthcare and organisational components involved.

The functional position assumed during an emergency should therefore not be defined rigidly and independently of the scenario, but should be consistent with the nature, scale, and complexity of the event, as well as with the coordination structures activated. From this perspective, the ability to maintain an up-to-date representation of the situation, integrate information from different sources, and support coordination is particularly important.

1.3 The Disaster Management Cycle and the Implementation of Mitigation Strategies

Healthcare emergency management develops through a continuous and dynamic process, commonly referred to as the Disaster Management Cycle. Developed within the international literature on Disaster Risk Management, this model represents a conceptual framework describing the main phases through which risk management activities are planned, implemented, and evaluated. Rather than a linear sequence of events, the disaster cycle is an iterative process in which the experience gained during each emergency contributes to improving the strategies and plans developed for subsequent events [4,3].

The cyclical approach reflects the progressive shift away from an exclusively reactive view of emergencies, recognising that reducing the impact of disasters depends on the continuity of planning activities and the constant updating of the healthcare system's organisational capacities [4,3,5]. Major international organisations, including the World Health Organization (WHO) and the United Nations Office for Disaster Risk Reduction (UNDRR), identify four fundamental phases of the cycle: prevention and mitigation, preparedness, response, and recovery [4,3].

The prevention and mitigation phase encompasses all activities aimed at reducing the likelihood that an event will have significant consequences for population health or at limiting its effects when it cannot be prevented. In the healthcare setting, these activities include analysing risks within the territory, assessing the vulnerability of healthcare facilities, protecting critical infrastructure, and establishing organisational measures designed to reduce the population's exposure to different risk scenarios [4,3,2].

A central role is played by the Hazard Vulnerability Assessment (HVA), a methodology that enables the identification and classification of major natural, technological, biological, and human-induced hazards by assessing their likelihood of occurrence and their potential impact on the healthcare system [12]. HVA is a fundamental tool for establishing planning priorities and supporting the development of mitigation interventions [12].

Preparedness encompasses all activities required to ensure that the healthcare system is capable of responding effectively to an emergency. During this phase, emergency plans are developed, operational protocols are defined, exercises are organised, and training programmes are implemented to assess the effectiveness of procedures and coordination among the different stakeholders involved [3,2].

Particular importance is given to surge capacity planning, understood as the ability of the healthcare system to adapt and temporarily increase its capacity to provide care through the coordinated management of space, staff, and material resources in response to an extraordinary increase in demand [13]. The proactive assessment of surge capacity makes it possible to identify potential organisational weaknesses and develop strategies aimed at ensuring continuity of care during particularly complex events [13].

Preparedness also includes the periodic evaluation of plans through simulations, tabletop exercises, and full-scale exercises, which are essential tools for assessing the preparedness level of healthcare organisations and identifying potential areas for improvement [3,2].

The response phase involves the activation of the measures established in emergency plans following the occurrence of an event. The primary objective is to limit the health consequences of the disaster, provide care to patients, and preserve, as far as possible, the continuity of essential services [3,2].

During this phase, continuous monitoring of the operational scenario, dynamic allocation of available resources, and coordination among the different components of the emergency system become particularly important. The speed with which decisions are made and the ability to adapt the organisation to the evolving event are key determinants of an effective response [3].

In contexts where healthcare demand significantly exceeds available resources, extraordinary organisational strategies may be required to ensure the most effective use of healthcare resources. The operational approaches through which these strategies are

implemented will be examined in greater detail in the section dedicated to the professional competencies of the Disaster Manager.

The recovery phase encompasses activities aimed at progressively returning to normal conditions and restoring the full functionality of the healthcare system. It is not limited to the reconstruction of damaged facilities, but also includes the restoration of healthcare services, psychological support for the population and healthcare professionals, the review of organisational procedures, and the assessment of critical issues that emerged during emergency management [4,3].

Modern Disaster Risk Reduction strategies place particular emphasis on the Build Back Better principle introduced by the Sendai Framework, according to which the recovery phase should represent an opportunity for improvement rather than simply a return to pre-disaster conditions [4].

Although the disaster cycle is conventionally represented as a sequence of four phases, in practice these phases are closely interconnected. Recovery activities inform new prevention strategies, while preparedness is continuously updated on the basis of experience gained during emergency response. This dynamic nature makes Disaster Management a permanent process of planning, monitoring, and improvement rather than a sequence of interventions limited to the emergency phase [4,3,5].

The adoption of this model enables healthcare systems to progressively develop their capacity to adapt to different risk scenarios, promoting emergency management based on organisational continuity, institutional learning, and the integration of planning with operational practice [3,5].

1.4 Regulatory Framework: From the Sendai Framework to the Italian Civil Protection Code

Healthcare emergency management operates within a complex system of strategies, regulations, and operational guidelines developed at the international, European, and national levels. The evolution of the discipline has progressively encouraged a shift from an approach primarily focused on event response towards a model that places increasing emphasis on prevention, preparedness, planning, and the strengthening of response capacities. This framework encompasses instruments with different levels of legal force: alongside non-binding international strategic instruments, there are international regulations, European Union acts, and national legislative provisions defining responsibilities, competencies, and coordination mechanisms [4,14,15,9].

At the international level, the main strategic reference for disaster risk reduction is the Sendai Framework for Disaster Risk Reduction 2015–2030, adopted in 2015 at the Third United Nations World Conference on Disaster Risk Reduction [4]. The Framework identifies five priorities for action:

- understanding disaster risk
- strengthening disaster risk governance
- investing in disaster risk reduction for resilience
- enhancing disaster preparedness for effective response
- during recovery, rehabilitation, and reconstruction phases

Although it is not a legally binding instrument, the Sendai Framework represents a fundamental strategic reference for guiding Disaster Risk Reduction (DRR) policies and promoting the integration of risk reduction into public policies [4].

With specific regard to healthcare, a fundamental international reference is represented by the International Health Regulations (IHR 2005), adopted by the World Health Assembly in 2005 and entering into force in 2007 [14]. Unlike the Sendai Framework, the IHR constitute a legally binding instrument for States Parties and establish a shared framework for preventing, detecting, assessing, notifying, and responding to events that may pose public health risks with potential international significance [14]. The IHR also require the development and maintenance of specific national surveillance and response capacities and regulate international mechanisms relating to Public Health Emergencies of International Concern (PHEIC) [14].

Within the European Union, cooperation in the field of civil protection is supported by the Union Civil Protection Mechanism, established by Decision No. 1313/2013/EU and subsequently amended and strengthened [15]. The Mechanism is intended to improve cooperation between the Union and participating States in disaster prevention, preparedness, and response activities, facilitating the coordination and mobilisation of available capacities [15]. The subsequent development of rescEU further strengthened this architecture through the establishment of European capacities designed to supplement national capacities when these prove insufficient to meet the needs arising from an emergency [15].

At the national level, the main legislative reference is Legislative Decree No. 1 of 2 January 2018 – the Italian Civil Protection Code, which regulates the National Civil Protection Service and defines its objectives, components, operational structures, and activities [9]. The Code includes within the scope of civil protection activities relating to risk forecasting, prevention and mitigation, emergency management, and recovery from emergency conditions, outlining a system in which public administrations, territorial authorities, operational structures, and other stakeholders contribute, according to their respective competencies, to the protection of the population [9].

The National Service is organised according to a multi-level governance model, in which responsibilities are distributed among the State, Regions, Autonomous Provinces, and local authorities, in accordance with the principle of subsidiarity [9]. The healthcare sector participates in this system through its competent structures and services, contributing to rescue and assistance activities for the population and to the protection of health during emergencies. Coordination between the healthcare system and civil protection therefore becomes particularly important during events capable of causing a sudden increase in healthcare needs or impairing normal response capacity [9,16].

At the operational level, healthcare planning for major emergencies has also been progressively developed through specific national guidelines. The General Criteria for the Organisation of Healthcare Relief in Disasters, issued by the Department of Civil Protection, have provided a reference framework for organising the healthcare response and coordinating the different components involved in rescue operations [16]. Within the context of hospital preparedness, this approach is reflected in the development of organisational tools designed to manage extraordinary conditions, including plans for mass casualty influx and procedures for the potential evacuation of healthcare facilities. Among hospital planning tools, particular importance is given to the Internal Emergency Plan for Mass Casualty Influx (Piano di Emergenza Interna per il Massiccio Afflusso di

Feriti – PEIMAF), which is designed to temporarily adapt hospital organisation to an influx of patients exceeding the capacity manageable through ordinary operating procedures. This is complemented by plans and procedures for the evacuation of healthcare facilities, frequently referred to in organisational practice as PEVAC, which are intended to regulate the safe transfer of patients, healthcare professionals, and other persons present within the facility when the circumstances of an event require partial or complete evacuation. The specific configuration of these instruments must be aligned with applicable legislation, regional provisions, and the organisation of the individual healthcare facility, avoiding the assumption that their terminology and regulatory framework are uniform throughout the national territory.

Alongside legislative sources, guidelines, directives, and technical-operational documents issued by the competent institutions are particularly relevant. These instruments contribute to translating general principles into procedures applicable to healthcare planning, major emergency management, facility preparedness, and coordination among the organisations involved [9,16].

Overall, the framework outlined above constitutes a multi-level governance system in which international strategic instruments, obligations arising from international health cooperation, European legislation, and national provisions contribute, with different legal status and levels of enforceability, to risk and emergency management [4,14,15,9]. For the Healthcare Disaster Manager, knowledge of this architecture is not merely a theoretical requirement, but a prerequisite for appropriately positioning planning and coordination activities within the institutional and organisational responsibilities of the different stakeholders involved.

1.5 Professionalisation and Competencies of the Healthcare Disaster Manager

The increasing complexity of healthcare emergencies requires professionals who are capable of operating in contexts characterised by uncertainty, time pressure, multidisciplinary, and the need for coordination among different organisations. From this perspective, professionalisation in healthcare Disaster Management requires a structured set of knowledge, skills, and competencies that integrates technical and organisational preparedness with cognitive, interpersonal, and decision-making abilities. International literature has progressively proposed frameworks and core competencies for professionals involved in disaster preparedness and response, while highlighting significant heterogeneity in training models and the competency domains considered [6–8,10].

For the purposes of this thesis, these competencies can be grouped into three complementary functional areas. The first area includes technical and organisational competencies related to planning, knowledge of response systems, resource management, and the application of shared procedures and protocols. The second concerns cognitive and decision-making competencies, which are necessary to interpret dynamic scenarios, manage incomplete information, and make decisions under conditions of uncertainty. The third includes interpersonal and leadership competencies, which are essential for effective communication, the coordination of multidisciplinary teams, and the promotion of collaboration among different professionals and

organisations. The relevance of non-technical skills in healthcare disaster response is also supported by more recent literature focusing on medical disaster responders [71]. Professionalisation also requires knowledge of the main organisational models, command systems, and communication tools used in emergency management. Among these, the Incident Command System (ICS), incorporated within the broader National Incident Management System, provides a standardised structure for organising command, coordination, and resource management functions [17]. Similarly, structured communication tools such as METHANE contribute to the standardised initial transmission of information regarding the incident scenario [19]. Knowledge of these tools does not imply overlapping with the specific functions of individual operational components, but rather facilitates the use of shared terminology and procedures and, consequently, interoperability.

A further area concerns the management of situations in which healthcare demand may exceed available resources. Under such circumstances, knowledge of the principles of Crisis Standards of Care is relevant to understanding how healthcare systems can progressively adapt organisational arrangements and criteria for resource utilisation during particularly severe emergencies [18]. Their application, however, requires clearly defined decision-making processes, institutional responsibilities, and ethically and organisationally sustainable criteria, and cannot be reduced to the autonomous decision of an individual professional.

The acquisition of Disaster Management competencies cannot be based exclusively on theoretical learning. Training should include regular opportunities for continuing education and exercises that enable professionals to apply knowledge and procedures in simulated scenarios and develop interdisciplinary collaboration skills. From this perspective, simulation and different types of exercises represent important tools for professional and organisational preparedness [44]. Training methods, the role of debriefing, and competency assessment systems will be examined in greater detail in subsequent chapters.

The Train-the-Trainer model may also play a relevant role in this process, enabling appropriately trained professionals to contribute to the dissemination of knowledge and methodologies within organisations [48]. In healthcare Disaster Management, this approach can support the development of a shared body of competencies without replacing the need for structured training programmes and appropriate assessment criteria.

The progressive digitalisation of emergency management also introduces the need for specific information and technological competencies. The Disaster Manager must be able to understand the potential and limitations of the tools used to collect, integrate, and represent the information required for decision-making processes. This competency does not correspond to specialist technical mastery of individual technologies, but rather to the ability to assess their usefulness within organisational and decision-making processes.

The professionalisation of the Healthcare Disaster Manager can therefore be interpreted as a continuous process of competency acquisition, maintenance, and assessment, rather than simply the attainment of theoretical knowledge. Training should enable the integration of technical-organisational, cognitive, decision-making, interpersonal, and digital competencies, preparing professionals to operate within complex and multidisciplinary systems.

Chapter 2 – Cognitive, Decision-Making and Leadership Competencies of the Disaster Manager

2.1 Situational Awareness: Building Situational Awareness

The ability to make effective decisions during an emergency largely depends on the quality of the information available and its correct interpretation. In contexts characterised by high dynamism, uncertainty, and time pressure, the Disaster Manager must be able to build and continuously update an accurate representation of the operational scenario. This cognitive process is defined as Situational Awareness (SA) and represents a fundamental component of decision-making in complex and dynamic systems [22].

The most widely established definition in the literature is that proposed by Mica R. Endsley (1995), according to which Situational Awareness consists of the perception of elements in the environment within a given volume of time and space, the comprehension of their meaning, and the projection of their status in the near future [22]. SA therefore does not simply correspond to the availability of data, but represents a cognitive process through which information is perceived, interpreted, and integrated into a coherent representation of the situation, enabling anticipation of its possible evolution [22].

The model developed by Endsley identifies three progressive levels of Situational Awareness: perception, comprehension, and projection [22].

The first level, perception, concerns the perception of relevant elements within the operational environment [22]. In a major emergency scenario, this may include, for example, the location of the event, the estimated number of people involved, environmental conditions, the presence of residual hazards, and the status of key infrastructure. The timeliness, reliability, and relevance of the available information are therefore essential conditions for building an adequate initial picture of the scenario.

The second level, comprehension, involves understanding the meaning of the perceived information and integrating it into a unified interpretative framework [22]. At this stage, the Disaster Manager assigns meaning to the available information, identifies relationships among the different elements of the scenario, and assesses their potential operational implications. Comprehension therefore makes it possible to transform initially fragmented data into a structured representation of the situation.

The third level, projection, concerns the ability to anticipate the future status of the elements within the scenario on the basis of their current condition and the understanding already acquired [22]. The decision-maker can thus formulate hypotheses regarding the evolution of the event, anticipate potential critical issues, and assess the possible consequences of different operational options. This predictive dimension enables the decision-making process to adopt a proactive rather than exclusively reactive approach.

Situational Awareness should be regarded as a dynamic process that is continuously updated as the operational environment evolves. The acquisition of new information may alter the perception of the elements within the scenario, their interpretation and, consequently, the projections formulated by the decision-maker [22]. SA therefore does not represent a static state, but rather a cognitive process closely interconnected with decision-making.

The development and maintenance of Situational Awareness can be impaired by high informational and cognitive workloads. During an emergency, the Disaster Manager may simultaneously receive information from multiple sources, which may at times be incomplete, conflicting, or subject to rapid change. Under conditions of information overload, a greater quantity of information does not necessarily improve the quality of the decision-making process and may, on the contrary, make it more difficult to identify and interpret the elements that are genuinely relevant [23]. Stress, time pressure, fatigue, and interruptions are additional factors that may interfere with the cognitive processes involved in developing and maintaining Situational Awareness.

To reduce information fragmentation and facilitate coordination, emergency management systems use the concept of the Common Operating Picture (COP), understood as a shared representation of relevant operational information developed through the collection, integration, and dissemination of the data required to manage the event [17]. The availability of a common operational picture promotes a more widely shared understanding of the scenario across different organisational levels and supports the coordination of decisions and resources [17]. However, the COP should not be interpreted as a static information product, but rather as a representation that must be continuously updated as the scenario evolves.

Technological developments have significantly expanded the range of tools available to support Situational Awareness. Geographic Information Systems (GIS) make it possible to acquire, integrate, analyse, and spatially represent geographical and operational information, facilitating the identification of affected areas, critical infrastructure, and available resources, while supporting the geographical interpretation of the scenario [24]. Their value in Disaster Management derives primarily from their ability to relate information from different sources within a coherent spatial representation.

Radio-Frequency Identification (RFID) technologies can support the tracking of patients, personnel, equipment, and other resources during the management of events involving large numbers of people [25]. The availability of up-to-date information on the location and movement of resources can contribute to improving the management of operational flows and the availability of information required for coordination. GIS and RFID can be complemented by digital dashboards, data-sharing platforms, and real-time monitoring systems, all of which contribute to building and continuously updating the operational information picture.

Situational Awareness therefore represents a fundamental component of decision-making in healthcare emergencies. The ability to perceive relevant elements, understand their meaning, and anticipate their evolution enables the Disaster Manager to transform heterogeneous information into an operational representation of the scenario, reducing uncertainty and facilitating the coordination of activities. This provides the basis for the decision-making processes described in the following section, which focuses on Decision-Making models applied to emergency management.

2.2 Decision Making Under Conditions of Uncertainty

Decision-making is a central component of emergency and disaster management, contexts in which decisions must frequently be made in the presence of incomplete information, limited resources, time pressure, and rapidly evolving scenarios. Under

such conditions, a fully optimising model of rationality is difficult to apply. Simon described this limitation through the concept of bounded rationality, according to which decision-makers operate within constraints determined by the information available, time, and their own cognitive capacities, often seeking sufficiently satisfactory solutions rather than a theoretically optimal alternative [27].

The study of decisions made in highly complex real-world contexts subsequently contributed to the development of Naturalistic Decision Making (NDM). Research by Klein and colleagues has shown that experienced professionals, when operating under time pressure and conditions of uncertainty, do not necessarily proceed by systematically comparing numerous alternatives, but may recognise patterns in the current situation that they have previously encountered or that resemble prior experiences [26].

These observations form the basis of the Recognition-Primed Decision (RPD) model, in which an experienced decision-maker identifies a possible course of action based on recognition of the scenario and mentally evaluates its plausibility before implementing it. If the option appears compatible with the objectives and characteristics of the situation, it may be adopted without an extensive analytical comparison of multiple alternatives; if it proves inadequate, the process is reconsidered and a different option is evaluated [28]. The model therefore does not eliminate reasoning, but describes a process through which experience and mental evaluation can enable effective decisions even when the available time is limited.

The role of experience in the RPD model should not, however, be interpreted as an alternative to training. The ability to recognise meaningful patterns depends on the availability of cognitive schemas developed through exposure to previous situations and on the ability to apply them critically within the current context [26,28]. Experience may derive from professional practice and exposure to real events, but it can also be progressively enriched through training programmes that expose professionals to different problems and scenarios. Training and experience therefore represent complementary dimensions in the development of decision-making competence.

This relationship is particularly relevant in Disaster Management, since direct exposure to major events is not necessarily frequent or repeatable. In this context, the use of simulated scenarios can provide structured opportunities to engage with complex situations, apply knowledge, and practise decision-making processes under controlled conditions. This does not imply equating simulated experience with experience gained during a real event, but rather recognising the potential of training to broaden the range of situations that professionals have had the opportunity to encounter. The ways in which simulation and experiential learning can contribute to competency development will be examined in greater detail in section 2.5.

A further contribution to understanding Decision Making in complex environments comes from Weick's concept of sensemaking. When information is incomplete, ambiguous, or rapidly changing, decision-makers do not merely receive the available data passively, but progressively construct a meaningful representation of the situation by interpreting and contextualising information [29]. Decision-making therefore takes on a dynamic nature: interpretation of the scenario guides action, while the effects of that action generate new information that may require subsequent revision of the initial representation.

This iterative dimension is further represented by the OODA model – Observe, Orient, Decide, Act – which has subsequently been analysed as a dynamic process of decision-making adaptation [30]. The value of the model does not lie in a rigidly linear sequence of the four phases, but rather in the ability to observe the evolution of the scenario, orient its interpretation, make a decision, act, and use the information generated by that action to continuously update the process [30]. In highly variable contexts, this approach therefore emphasises the need to avoid static decisions and to maintain the ability to reassess choices in light of the evolving event.

The different models described should not be regarded as mutually exclusive. Bounded rationality highlights the constraints within which decisions are made [27]; Naturalistic Decision Making and the RPD model illustrate the role of experience and the recognition of meaningful patterns [26,28]; sensemaking emphasises the construction and revision of the meaning attributed to information [29]; and the OODA model highlights the iterative nature of the interaction between observation, decision, and action [30].

Overall, the literature suggests that Decision Making in emergencies cannot be reduced to a single process applicable indiscriminately to every situation. Theoretical knowledge, training, professional experience, scenario recognition, and analytical ability may carry different weight depending on the nature of the problem, the time available, and the quality of the information [26–30]. The development of decision-making competence therefore requires not only the acquisition of theoretical models, but also the ability to adapt the decision-making process to the characteristics of the scenario and to continuously review and update one's assessments.

2.3 The Disaster Mindset: Cognitive Adaptation and Uncertainty Management

The effectiveness of decision-making in emergencies does not depend exclusively on knowledge of models and procedures, but also on the professional's ability to adapt their reasoning to scenarios characterised by uncertainty, time pressure, and rapid evolution. The term Disaster Mindset is used to describe an integrated set of cognitive and behavioural dispositions that support the management of such conditions. Rather than constituting an independent and universally standardised theoretical model, it can be linked to well-established constructs in the literature on decision-making, cognition in complex environments, and organisational learning [22,26,29].

A fundamental component of this approach is the ability to operate in the presence of necessarily incomplete information. As highlighted by the models of bounded rationality and Naturalistic Decision Making, decision-makers operate within informational, cognitive, and temporal constraints and must often identify viable courses of action without being able to conduct an exhaustive analysis of all available alternatives [26,27]. The Disaster Mindset therefore implies the ability to tolerate a certain degree of uncertainty, make decisions proportionate to the information available, and subsequently reassess them as the scenario evolves.

A particularly relevant component is cognitive flexibility, understood as the ability to modify cognitive and behavioural strategies in response to changing environmental conditions [31]. In an emergency, this implies a willingness to revise previously formulated interpretations when new information emerges that is inconsistent with them, preventing initial plans and decisions from becoming rigid constraints. This ability

is particularly important in complex systems, where evolving scenarios can rapidly alter priorities, constraints, and available resources.

Closely related to this dimension is anticipatory thinking, defined as a cognitive process aimed at recognising and preparing for possible future developments by identifying signals, threats, and opportunities before they fully emerge [32]. Anticipation does not mean accurately predicting how an event will evolve, but rather developing plausible scenarios and preparing options that allow the response to be adapted more rapidly. This ability is clearly connected to the projection dimension of Situational Awareness described by Endsley [22,32].

Operating under conditions of uncertainty, however, exposes decision-makers to the influence of cognitive biases, namely systematic deviations in judgement that may affect the assessment of information and probabilities [33]. Relevant phenomena include confirmation bias, which may lead individuals to seek or interpret information in ways that are consistent with previously formulated hypotheses, while assigning less weight to evidence that contradicts them [34]. In an emergency environment, this mechanism may contribute to maintaining a representation of the scenario that has progressively become inadequate.

Another distortion relevant to risk perception is optimism bias, through which individuals may underestimate their personal likelihood of experiencing certain negative events compared with others [35]. In terms of preparedness, mechanisms that lead to the underestimation of risk may reduce the perceived need to prepare for low-probability, high-impact events. Stress-related narrowing of attention may also limit the simultaneous consideration of different elements within the scenario, making it necessary to use reassessment procedures, team-based discussion, and systematic updating of Situational Awareness.

Managing these cognitive vulnerabilities does not imply that biases can be completely eliminated, but requires the development of debiasing strategies and mechanisms for monitoring the decision-making process. Actively seeking conflicting information, periodically reassessing operational hypotheses, engaging in multidisciplinary discussion, and explicitly identifying the assumptions underlying a decision may help reduce the risk that an initial interpretation of the scenario is automatically maintained despite the emergence of new evidence [34].

The Disaster Mindset also encompasses a dimension of learning from experience. Real events, exercises, and simulations can be transformed into opportunities for improvement through structured processes of analysis and review. From this perspective, learning involves not only correcting individual operational errors, but also the ability to reconsider established assumptions, procedures, and interpretative models. This approach reflects the concept of double-loop learning, in which experience may lead to the revision not only of actions, but also of the underlying assumptions that generated them [36].

This dimension is linked to the concept of resilience, which in a professional context should not be reduced solely to an individual's ability to withstand stress. Resilience encompasses adaptive processes through which individuals and organisations maintain or restore functional capacity under adverse conditions [37]. For the Disaster Manager, this also involves the ability to recognise personal limitations, make effective use of team and organisational resources, and maintain adequate decision-making capacity during prolonged or high-impact situations.

A complementary perspective is offered by the concept of the Black Swan, proposed by Nassim Nicholas Taleb to describe events characterised by extreme rarity, high impact, and a tendency to be retrospectively rationalised as more predictable than they actually were before their occurrence [38]. Although it does not constitute a specific Disaster Management model, this perspective highlights the limitations of prediction and the need to avoid excessive dependence on predetermined scenarios. In emergency management, its value is therefore primarily conceptual: preparing systems and professionals not only for known events, but also for the possibility that the actual scenario may differ significantly from planned assumptions.

Taken together, cognitive flexibility, anticipatory thinking, awareness of biases, learning from experience, and adaptive capacity define what is referred to in this thesis as the Disaster Mindset. The concept does not replace the cognitive models described previously, but represents an applied synthesis focused on the Disaster Manager's ability to operate effectively under conditions of uncertainty. This approach introduces the interpersonal dimension of decision-making: in emergencies, individual adaptation must be translated into coordination, communication, and the ability to lead multidisciplinary teams.

2.4 Leadership, Human Factors and Non-Technical Skills in Emergency Management

Healthcare emergency management requires leadership capabilities suited to contexts characterised by time pressure, uncertainty, high operational workload, and the need to coordinate professionals from different disciplines and organisations. Under such conditions, the effectiveness of the response depends not only on the technical and professional competencies of individual practitioners, but also on their ability to communicate, cooperate, make decisions, and use available resources in a coordinated manner. These dimensions fall within the field of Non-Technical Skills (NTS), which are considered relevant components of safety and performance in complex systems [39].

Non-technical skills include cognitive, social, and personal abilities that complement technical competencies and contribute to the effective and safe performance of professional activities. Their systematisation also originates from experience gained in aviation and human factors research and has subsequently been developed across numerous high-risk healthcare settings. The most commonly identified dimensions include Situational Awareness, Decision Making, communication, teamwork, leadership, and workload management [39,40]. In complex healthcare systems, problems involving communication, coordination, and interaction among professionals may contribute to adverse events, highlighting the need to consider safety as a property of the entire system rather than exclusively as the result of individual technical performance [41].

From this perspective, the Disaster Manager must be able to adapt leadership approaches to the characteristics and evolution of the scenario. A useful reference is Adaptive Leadership, developed by Ronald Heifetz, which distinguishes the exercise of leadership from formal authority and focuses on the ability to mobilise individuals and organisations to address complex problems for which available technical solutions are insufficient [42]. Applied to healthcare emergencies, this perspective emphasises the

ability to facilitate collaboration, integrate different areas of expertise, and adapt the organisation in response to changing operational conditions.

Communication plays a central role, as it is essential for team coordination and operational safety. In environments characterised by time pressure and interdependence among professionals, incomplete, ambiguous, or unconfirmed information may contribute to the development of divergent representations of the scenario and compromise coordination. The use of structured communication methods, confirmation of message receipt, and timely sharing of relevant information can contribute to more reliable interactions within the team [40,43].

At the same time, teamwork represents an essential component of emergency response. The Healthcare Disaster Manager operates within multidisciplinary teams in which physicians, nurses, technicians, logistics personnel, and representatives of different organisations must rapidly integrate their knowledge and competencies in pursuit of common objectives. Leadership, mutual performance monitoring, communication, and adaptability are fundamental dimensions of team effectiveness in complex environments [40,43].

These aspects are situated within the broader theoretical framework of Human Factors, a discipline that studies interactions between people and other elements of a system with the aim of understanding and improving safety and performance. In healthcare, this perspective considers not only the individual characteristics of professionals, but also factors such as process design, technologies, the working environment, organisational structures, cognitive workload, fatigue, and interface characteristics [41,44]. Errors are therefore analysed within the system in which they occur, rather than being automatically attributed solely to individual performance [41].

Among the approaches developed to improve the use of human resources in high-risk systems, Crew Resource Management (CRM), originally developed in aviation and subsequently adapted to healthcare, is particularly relevant. CRM focuses on communication, leadership, teamwork, Situational Awareness, and resource management, with the aim of improving coordination and reducing vulnerabilities associated with human factors [45]. Similar principles have been incorporated into Team Resource Management programmes and other healthcare training models aimed at developing non-technical skills.

A further contribution comes from the literature on High Reliability Organizations (HROs). Weick and Sutcliffe describe high-reliability organisations through principles such as preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise [46]. These principles are particularly relevant to emergency management, where apparently minor signals may rapidly become significant and decision-making authority should be able to draw upon the expertise actually available within the system.

The Human Factors perspective is also closely linked to the concept of Safety Culture, understood as the set of values, attitudes, perceptions, and practices through which an organisation prioritises safety. Within this context, Just Culture is particularly relevant, as it seeks to distinguish human error from behaviours involving different levels of responsibility, avoiding both an indiscriminately punitive culture and an absence of accountability [47]. This approach encourages event reporting and analysis, making it possible to identify not only individual actions but also the organisational and systemic conditions that contributed to their occurrence [41,47].

Leadership competencies are also particularly important when exceptional circumstances require the activation of Crisis Standards of Care. In such situations, transparency of processes, consistency of decision-making criteria, and organisational coordination are essential to support ethically justifiable decisions in conditions of severe resource scarcity [19]. For the Disaster Manager, this also implies the need to promote communication, collaboration, and mutual support within teams, recognising the impact that particularly burdensome decisions may have on professionals.

Taken together, leadership, Human Factors, and non-technical skills represent complementary dimensions of healthcare emergency management. The ability to coordinate people and resources, communicate effectively, recognise cognitive and organisational limitations, and promote a safety-oriented culture enables individual decisions to be translated into more coordinated collective action. The development of these competencies therefore requires training programmes that integrate technical and professional knowledge, simulation, teamwork, and reflection on organisational dynamics.

2.5 Competency Development: Simulation, Experiential Learning and Train-the-Trainer

The cognitive, decision-making, and interpersonal competencies required in emergency management cannot be developed exclusively through the acquisition of theoretical knowledge. Major events are relatively infrequent and do not necessarily provide professionals with opportunities to gain extensive and repeated direct experience. Training therefore serves to create structured opportunities in which knowledge and experience can be integrated, allowing professionals to apply what they have learned to scenarios characterised by complexity, uncertainty, and the need for interdisciplinary coordination [8,11,20].

A well-established theoretical reference is David A. Kolb's Experiential Learning model, according to which learning develops through a cyclical process comprising concrete experience, reflective observation, abstract conceptualisation, and active experimentation [48]. Applied to Disaster Management, this model makes it possible to interpret simulated experience not as an isolated training episode, but as part of a process in which action is subsequently analysed, re-evaluated, and used to address new situations.

This approach is particularly relevant to the relationship between training and experience discussed in section 2.2. Simulation does not replace experience gained during a real emergency, but it allows professionals to broaden the range of situations they may encounter. Through exposure to different scenarios, professionals can practise applying their knowledge, recognising relevant elements, coordinating with other stakeholders, and adapting decisions as operational conditions evolve.

However, simulations and exercises must be designed according to the objectives they are intended to achieve. There is no single type of exercise that is suitable for every purpose. Tabletop exercises are primarily intended to facilitate discussion of scenarios, roles, procedures, and decision-making processes in an environment with limited operational pressure; functional exercises make it possible to assess specific functions and organisational capabilities; full-scale exercises, by contrast, involve personnel,

facilities, and resources in more complex operational activities, allowing broader components of the response to be tested [21]. The progression in complexity should therefore be consistent with the training and organisational objectives, the level being assessed, and the resources available. The current text already appropriately introduces this distinction, which can be further developed in response to the supervisor's observation.

From this perspective, a relevant competency of the Healthcare Disaster Manager consists not only in participating in exercises, but also in contributing to their design. This requires identifying in advance which capability is to be practised or assessed, which stakeholders should be involved, what level of complexity is appropriate, and which type of scenario is most consistent with the intended objective. An exercise focused on strategic and decision-making processes will require different characteristics from one designed to test the operational activation of resources and procedures. This design capability makes it possible to use training not as an occasional activity, but as a tool integrated into organisational preparedness.

The value of simulated experience also depends on the opportunity to subject what occurred to subsequent structured reflection. Debriefing allows participants to reconstruct the actions performed, examine decision-making processes and team dynamics, and identify potential improvement strategies [49]. Consistent with the experiential learning cycle, post-action reflection therefore makes it possible to transform experience into knowledge that can be applied in future situations. In this context, errors observed during simulation can also become the subject of analysis, allowing the cognitive, communicative, and organisational factors that contributed to their occurrence to be examined.

The multidisciplinary nature of emergencies also makes Interprofessional Education (IPE) particularly relevant. Shared learning among professionals from different disciplines can improve mutual understanding of roles, responsibilities, and operational constraints and provide opportunities to practise common approaches to communication and collaboration. This dimension is particularly important in Disaster Management, where the effectiveness of the response depends on interactions among professionals and organisations that, under ordinary conditions, may operate according to different structures and procedures.

Within this process, Train-the-Trainer (TtT) primarily serves to support the dissemination and sustainability of competencies. Appropriately trained professionals can contribute to transferring knowledge and methodologies to other practitioners, progressively expanding the number of trained personnel and supporting the continuity of training programmes [48]. Its effectiveness, however, depends on the quality of trainer preparation and on the consistency of the content delivered with the objectives of the programme.

Digital technologies can further expand training opportunities through virtual environments and simulated scenarios, making it possible to modify conditions, variables, and levels of complexity without necessarily reproducing a field exercise. These tools should be considered complementary to, rather than substitutes for, multidisciplinary interaction and practical exercises.

The development of Disaster Manager competencies can therefore be interpreted as a process in which knowledge, experience, and training mutually reinforce one another. Training provides interpretative and methodological tools; experience, whether real or

simulated, enables their application to concrete situations; and reflection allows what has been observed to be re-evaluated and used to guide subsequent training activities. From this perspective, the Disaster Manager also assumes a role in promoting preparedness, contributing to the systematic assessment of the organisation's ability to address different scenarios and transforming these assessments into structured opportunities for exercises and training.

Chapter 3: Competency Assessment, Organisational Quality and Continuous Improvement

3.1 International Frameworks for Competency Standardisation

The increasing complexity of healthcare emergencies has highlighted the need to establish shared reference standards for the training and assessment of professionals involved in disaster management. The literature has documented significant heterogeneity among the competency models developed in this field, both in terms of the terminology used and with regard to their content, target groups, and the criteria adopted for their definition [6,8]. Such variability makes it more difficult to compare training programmes and assessment systems and highlights the need for reference frameworks capable of promoting greater consistency in professional preparedness.

In response to these challenges, competency frameworks and systems of core competencies have progressively been developed to identify the knowledge, skills, and behaviours considered necessary to operate across different areas of disaster medicine and emergency public health [6–11]. Unlike operational protocols, which define procedures and methods of intervention under specific circumstances, competency frameworks primarily describe what professionals should know and be able to apply, providing a common basis for curriculum design, training, and competency assessment. A significant step in the standardisation process is represented by the definition of core competencies for Disaster Medicine and Public Health Preparedness. The work of Walsh and colleagues contributed to the identification of cross-cutting competencies for professionals involved in disaster preparedness and response [7], while Schultz and colleagues developed a standardised set of all-hazard competencies for acute care physicians, nurses, and emergency medical services professionals [10]. Subsequent literature reviews have nevertheless highlighted persistent differences among the various models, confirming the need for greater harmonisation of content, competency levels, and the methods through which these competencies are assessed [8].

In the nursing field, a specific international reference is represented by the International Council of Nurses (ICN) Core Competencies in Disaster Nursing. The updated version of the framework organises competencies into domains relating to the different dimensions of disaster preparedness and response, providing a reference for the education, professional development, and assessment of nurses working in emergency and disaster settings [50]. The value of the model lies not only in identifying the required competencies, but also in providing a shared reference framework that can be adapted to different professional levels and organisational contexts.

The process of competency standardisation should be situated within the broader framework of Health Emergency and Disaster Risk Management (Health EDRM) promoted by the World Health Organization [3]. Strictly speaking, Health EDRM is not a professional competency framework, but rather provides a systemic framework in which the development of healthcare workforce capabilities represents a component of preparedness and overall risk management. From this perspective, individual competencies are embedded within a broader organisational and institutional capacity aimed at preventing, preparing for, responding to, and recovering from the effects of emergencies [3,2].

Convergence towards shared reference standards also concerns the design of training programmes. Analyses of educational initiatives developed within the European context have highlighted significant differences in the content, methodologies, and objectives of available programmes [11]. In response to these challenges, initiatives have been developed to define more harmonised curricula aimed at building common competencies among professionals expected to operate in national and international settings [20]. Standardisation therefore serves not only an educational function, but also an organisational one, since a shared foundation of knowledge and competencies can facilitate the integration of professionals from different systems and organisations.

Alongside competency standardisation is a distinct but complementary field concerning the standardisation of disaster research and scientific documentation. In this area, the World Association for Disaster and Emergency Medicine (WADEM) has contributed to the development of shared methodologies for describing, evaluating, and analysing events. Of particular relevance is the Utstein approach, developed with the aim of improving the comparability of research in Disaster Medicine through the adoption of more consistent concepts, terminology, and reporting criteria [51]. Its purpose is therefore not to define professional competencies, but rather to make the documentation of events and related management activities more systematic and comparable.

The distinction between competency frameworks and methodological standards for research is particularly important. The former identify competency domains and levels that can guide training design and professional assessment; the latter provide common criteria for describing and analysing events and interventions. The two dimensions are nevertheless complementary: the availability of shared terminology and criteria facilitates the production of comparable evidence, while the systematic analysis of experience can contribute to the revision of training programmes and competency standards themselves.

The adoption of shared frameworks should not be interpreted as a process of rigid standardisation of operational practices. Emergency scenarios differ in terms of epidemiological characteristics, resource availability, healthcare system organisation, and regulatory context. Standards must therefore retain sufficient adaptability while preserving a common core of competencies that can serve as a reference for training and assessment [6,8,20]. From this perspective, standardisation and adaptability are not opposing objectives, but complementary components of a quality-oriented system.

Standardisation therefore provides the link between competency definition, training design, and outcome assessment. Explicitly identifying what professionals are expected to know and be able to apply is a prerequisite for subsequently determining which tools can be used to observe, measure, and document these capabilities. Modern competency assessment systems are developed on this basis.

3.2 Competency Assessment and Professional Certification Systems

Defining expected competencies is not sufficient to demonstrate that they have actually been acquired. It is therefore necessary to establish assessment systems capable of systematically evaluating knowledge, applied skills, and professional performance. From this perspective, Competency-Based Education (CBE) directs training towards explicitly

defined and observable outcomes, emphasising the demonstration of acquired competencies rather than mere participation in a training programme [52].

The complexity of the competencies required in Disaster Management makes reliance on a single assessment tool unlikely to be adequate. Programmatic assessment involves integrating multiple sources of evidence collected over time in order to develop a comprehensive judgement of competency progression [53]. Different assessment tools may be used for this purpose, including structured assessments such as Objective Structured Clinical Examinations (OSCEs) [54].

These processes should not be confused with the existence of a universally recognised professional certification.

In healthcare Disaster Management, the sources considered in this thesis do not support the identification of a single international certification system for the Healthcare Disaster Manager. Standards, training programmes, and recognition systems have been developed by different organisations, but their purposes and fields of application do not necessarily overlap. Similarly, the classification processes established within the World Health Organization's Emergency Medical Teams (EMT) initiative primarily concern the capabilities and operational standards of teams and organisations and do not constitute a universal certification of individual professionals [56,57].

Assessment should also consider the maintenance of competencies over time. Continuing Professional Development (CPD) provides a framework for incorporating professional updating and assessment into an ongoing process [58]. Portfolios, documentation of training activities, and other forms of longitudinal evidence may contribute to this process, provided that they are not interpreted as equivalent to the demonstration of competence.

The assessment of the Healthcare Disaster Manager can therefore be conceived as a process integrating competency standards, evidence of performance, recognition of qualifications, and continuing professional development. This approach appears particularly relevant in a field in which professionalisation remains heterogeneous and where the definition of shared assessment criteria could contribute to making professional pathways and competencies more comparable.

3.3 Simulation as a Tool for Competency Assessment

In addition to the training function described in section 2.5, simulation can be used as a tool for performance assessment. The controlled reproduction of complex scenarios makes it possible to observe participants' behaviour while they perform defined tasks, generating evidence that would be difficult to obtain solely through the assessment of theoretical knowledge.

In healthcare Disaster Management, this possibility is particularly relevant because many competencies must be applied under conditions characterised by time pressure, incomplete information, the need for coordination, and interdependence among different functions. Simulation therefore makes it possible to observe not only the performance of individual tasks, but also communication, coordination, leadership, and decision-making processes within the scenario [44].

For simulation to serve a meaningful assessment function, objectives must be defined in advance and translated into observable criteria. Assessment can be supported through

checklists, structured rating scales, and behavioural markers used to describe relevant behaviours and reduce, as far as possible, the subjectivity of observation. The selection of indicators should be consistent with the competencies that the scenario is actually intended to assess.

It is also important to distinguish individual performance from team and organisational performance. An unsatisfactory outcome during an exercise is not necessarily attributable to the competence of an individual professional, but may depend on procedures, communication, resource availability, the distribution of responsibilities, or interactions among different components of the system. Assessment should therefore take into account the level at which performance is being observed, avoiding the automatic attribution of organisational shortcomings to individuals.

From this perspective, exercises can generate evidence that is useful not only for assessing professional competencies, but also for identifying preparedness gaps and weaknesses in organisational processes. Assessment findings become valuable when they are subsequently analysed and used to guide corrective interventions, procedural updates, and future training activities.

Simulation therefore represents a potential link between expected competence and observable performance. Its value as an assessment tool depends on the alignment between objectives, scenario design, observation criteria, and level of analysis; in the absence of such conditions, there is a risk that the exercise will produce only general impressions of performance without providing sufficiently structured evidence to support an assessment process.

3.4 After Action Review, Continuous Improvement and Organisational Learning

The conclusion of an emergency or exercise does not mark the end of the Disaster Management process. The information generated during the response can be used to identify critical issues, recognise effective practices, and guide subsequent organisational improvement. From this perspective, post-event analysis provides a link between operational experience and the review of response capacity [3,61].

The After Action Review (AAR) is a structured tool for analysing what occurred by comparing what was planned with what was actually observed and identifying demonstrated capabilities, critical issues, and potential improvement actions [61]. Its purpose is not merely to reconstruct the event, but to generate information that can be used to guide corrective interventions.

It is important to distinguish the AAR from the educational debriefing described in section 2.5. Although both involve reflection following an experience, debriefing is primarily focused on participant learning [60], whereas the AAR considers the response and opportunities for system improvement more broadly [61]. This distinction makes it possible to keep individual and team learning separate from organisational review, while recognising their complementary nature.

The identification of a critical issue does not, however, in itself constitute a lesson learned. Learning acquires organisational value when the findings of the analysis are translated into a change that can be concretely implemented, such as the revision of procedures and plans, modification of processes, redefinition of responsibilities, or identification of specific training needs. The actions introduced should also be

subsequently reassessed to determine whether they have actually produced the expected improvement [61,62].

This creates a process of continuous improvement in which evidence derived from events and exercises informs subsequent planning. Quality improvement does not simply consist of identifying problems, but requires knowledge and evidence to be used to make concrete changes to processes and assess their effects [62]. Identified critical issues can therefore become new objectives for interventions or exercises, making it possible to evaluate the effectiveness of the changes introduced over time.

Within this process, the Healthcare Disaster Manager can contribute to the collection and systematisation of evidence, the comparison between planned and observed activities, and the translation of identified critical issues into proposals for improvement. This function should be performed within the organisation's existing systems of responsibility, without creating an autonomous or hierarchically superior level of assessment in relation to the competent structures.

Organisational learning therefore occurs when experience does not remain confined to individual participants but contributes to producing verifiable changes in organisational processes. Assessment, AAR, and improvement actions can thus be regarded as interconnected components of a process through which experience is transformed into knowledge and knowledge into organisational change [61,62].

Chapter 4: Technologies and Decision-Support Tools in Healthcare Disaster Management

Technologies applied to healthcare Disaster Management do not operate independently of organisational and decision-making processes, but derive their value from the functions they support across the different phases of the disaster cycle. Some are primarily applied to planning and preparedness, others become more relevant during the operational response, while additional tools can contribute to assessing the effects of an event and to the subsequent review of response capacity. This distinction should not be regarded as rigid, since the same tool may perform different functions across different phases. This chapter therefore examines GIS, digital platforms, quantitative models, and specialised tools not only in relation to their technical characteristics, but above all with regard to the functions they can perform in planning, coordination, and decision-support processes.

4.1 Geographic Information Systems and Decision Support

The healthcare management of a disaster has a significant spatial dimension, since exposed populations, critical infrastructure, healthcare facilities, transport routes, resources, and hazards are geographically distributed. Even when they are not routinely used, Geographic Information Systems (GIS) make it possible to acquire, organise, integrate, and represent information associated with a geographical component, allowing data from different sources to be linked within a coherent spatial representation [24].

The usefulness of GIS varies according to the phase of the disaster cycle. During mitigation and preparedness activities, geospatial analysis can support the identification of exposed areas, the location of vulnerable populations and healthcare infrastructure, as well as the analysis of accessibility and the geographical distribution of resources [24]. Overlaying different layers of information also makes it possible to compare hazards, vulnerabilities, and available capacities, contributing to the development of scenarios that can support preparedness planning [24].

During the response phase, geospatial information can assume a more dynamic function. Data relating to the extent of the event, infrastructure accessibility, resource locations, and healthcare facility availability can be integrated to represent the evolving scenario and support the assessment of operational alternatives [24]. During the recovery phase, the same tools can contribute to the spatial representation of the effects of the event and to the identification of areas in which recovery and monitoring activities should be prioritised [24]. GIS therefore performs a cross-cutting function: what changes across the different phases is not necessarily the tool itself, but rather the nature of the data used and the decision-making problem to be addressed.

Building on this foundation are Decision Support Systems (DSS), which are designed to assist in the analysis of complex problems through the integration of data, models, and analytical tools [63]. GIS and DSS are not synonymous: GIS is specifically oriented towards the management and analysis of geographical information, whereas a DSS may integrate spatial information with healthcare, logistical, epidemiological, or environmental data in order to compare scenarios and decision alternatives [24,63]. This

distinction, already present in the original text of the thesis, is conceptually useful and should be retained.

The effectiveness of these tools, however, depends on the quality of the information on which they are based. Accuracy, completeness, timeliness, and suitability for users' needs influence the ability to transform data into genuinely useful information [65]. In complex healthcare systems, interoperability is also particularly important, as it enables information from different systems to be integrated and used consistently [66]. The availability of increasing quantities of data does not therefore automatically result in improved decision quality.

For the Healthcare Disaster Manager, an interest in GIS and DSS does not necessarily imply specialist technical expertise in the design or management of such systems. Rather, the relevant function is to understand what information is required for the problem being addressed, assess its reliability and limitations, and critically interpret the outputs produced, integrating them with other information available within the decision-making process. Digital tools should therefore be regarded as supporting, rather than replacing, professional judgement [63,65].

4.2 Digital Platforms for Operational Coordination

The management of complex emergencies requires information from different organisations and operational levels to be collected, updated, and shared within timeframes compatible with response requirements. Digital coordination platforms can support this process by integrating information relating to the event, available resources, infrastructure, and ongoing activities within a common information environment [17].

Their function varies according to the phase of the disaster cycle. During preparedness, these systems can be configured to organise the information, procedures, and resources required for the response and to test in advance the mechanisms for information exchange among the structures involved. During the response phase, they primarily assume an operational function, facilitating the updating and distribution of information required for the coordination of activities and resources [17].

A structured example of the digitalisation of information management is the INSARAG Coordination & Management System (ICMS), developed within the International Search and Rescue Advisory Group to support coordination activities during international Urban Search and Rescue operations. The system enables information from teams and operational sites to be collected, organised, and represented according to shared criteria, supporting the activities of the USAR Coordination Cell [67,68]. ICMS is not a general-purpose healthcare platform, but provides an example of how the standardisation of information flows can support inter-organisational coordination in complex scenarios.

Another relevant function of digital platforms concerns resource monitoring. The availability of up-to-date information on the location, allocation, and operational status of resources can help identify shortages, overlaps, and changes in available capacity. In specific contexts, tracking technologies such as Radio-Frequency Identification (RFID) can support the monitoring of patients, personnel, and equipment [25].

The effectiveness of these systems, however, depends on the reliability of the information they use. Incomplete, outdated, or irrelevant data may compromise the operational

picture; at the same time, an excessive volume of information may make it more difficult to identify the elements that are genuinely relevant [23,65]. The design and use of these platforms should therefore prioritise the quality and relevance of information over the mere quantity of available data.

Information sharing across different systems also requires adequate levels of interoperability, so that information can be transferred while maintaining consistent meaning across the organisations involved [66]. This requirement is particularly important during the response phase, when fragmentation of information systems may hinder timely information exchange and coordination.

Digital platforms should therefore be regarded as infrastructures supporting coordination, rather than as substitutes for organisational and decision-making processes. For the Healthcare Disaster Manager, the relevant competency primarily consists of identifying which information is required, critically assessing its reliability and currency, and promoting its use in a manner consistent with operational needs, without overlapping with the responsibilities of technical professionals responsible for managing these systems.

4.3 Quantitative Models for Healthcare Emergency Planning

Healthcare emergency planning requires the anticipated estimation of the potential relationship between healthcare demand and available capacity. Under conditions characterised by uncertainty and variability, quantitative models can support this process by enabling estimates to be formulated, scenarios to be compared, and the adequacy of resources in relation to expected needs to be assessed in advance [13,63]. Their application is particularly relevant during the preparedness phase, when information available before an event can be used to explore its potential health impact. Variables relating to the exposed population, expected healthcare demand, characteristics of the event, and available resources can be integrated to identify potential critical conditions and guide the advance allocation and sizing of the response. These results do not constitute deterministic predictions, but rather estimates that must be interpreted in light of the characteristics and uncertainty of the scenario.

One area in which this approach has a concrete application is represented by Mass Gathering Events (MGEs), planned events for which the advance availability of information makes it possible to apply quantitative tools to healthcare planning. Among these, the Maurer algorithm can be used to contribute to estimating the healthcare resources required according to the characteristics of the event, as provided for in Italy by State-Regions Agreement No. 91 of 5 August 2014. Its application is documented in the study concerning La Notte della Taranta, in which the model was used for the advance planning and sizing of healthcare resources [70]; this case will be discussed as an example in section 5.1.

Alongside tools aimed at determining resource requirements, models have been developed to forecast healthcare demand. Arbon, Bridgewater, and Smith proposed a predictive model for Mass Gathering Events designed to estimate patient presentation rates and transport rates to hospital facilities [74]. This approach makes it possible to use characteristics known before the event to forecast potential healthcare demand, thereby providing additional quantitative information for planning.

The Maurer and Arbon models therefore address complementary needs: the former is oriented towards the advance estimation of resource requirements, while the latter focuses on forecasting potential healthcare demand [70,74]. In both cases, the value of the model does not lie in eliminating uncertainty, but in making the assumptions underlying planning more explicit and providing quantitative information that can be integrated with professional and organisational assessment.

More generally, Decision Support System (DSS) tools can integrate data and models to enable comparison among different scenarios and decision alternatives [63]. The quality of the results, however, depends on the information and assumptions used: the accuracy, completeness, and suitability of the data for the purpose of the analysis influence the reliability of the outputs [65]. Quantitative results should therefore be interpreted critically rather than regarded as an automatic indication of the decision to be made.

For the Healthcare Disaster Manager, these tools provide support for preparedness planning by enabling expected demand to be compared with available resources and different organisational configurations to be assessed. The required competency does not necessarily involve specialist expertise in model development, but rather the ability to understand their assumptions, limitations, and results and to integrate them critically into the planning process.

4.4 Quantitative Indicators and Decision Support During Operational Response

Unlike the predictive models described in the previous section, which are used primarily during preparedness, operational indicators describe observable aspects of the response while an event is ongoing. They can contribute to monitoring changes in healthcare demand, resource utilisation, and the system's residual capacity, providing quantitative information to support decision-making.

A historical reference in the quantitative assessment of disasters is the Medical Severity Index (MSI) proposed by de Boer and colleagues, which was developed to contribute to the assessment and comparison of the medical severity of events [69]. The MSI should, however, be distinguished from indicators intended for operational monitoring: a tool designed to describe or compare the severity of different events does not automatically constitute a threshold for activating resources or procedures [69]. This distinction is important to avoid attributing to an indicator a decision-making function for which it was not designed.

During the response phase, monitoring may instead focus on variables directly related to the pressure placed on the healthcare system: the number and distribution of patients, response and transport times, availability of vehicles, bed occupancy, emergency department capacity, intensive care availability, and consumption of critical resources. The selection of indicators should be adapted to the characteristics of the event and to the decisions they are intended to support, since no single set of measures can be considered universally applicable to every scenario.

The relationship between healthcare demand and the capacity actually available is particularly important. During an event, the absolute number of patients provides incomplete information unless it is compared with the personnel, supplies, facilities, and systems that remain available. The CO-S-TR model specifically highlights the need to

consider staff, stuff, structure, and systems together when assessing healthcare response capacity [13]. Monitoring residual capacity can therefore contribute to the early identification of overload conditions and the need to reassess the configuration of the response.

Indicators may also be linked to operational thresholds when these have been defined in advance within plans, procedures, or escalation systems. Reaching a threshold may serve as a signal to reassess resource deployment or activate subsequent levels of response. A numerical change should not, however, automatically be interpreted as a trigger: its operational significance depends on the context, the reliability of the information, and the existence of predefined criteria.

The usefulness of indicators ultimately depends on the quality of the data used. Completeness, accuracy, timeliness, and suitability for users' needs influence the reliability of the information produced [65]. During the early stages of an emergency, when data may be incomplete or rapidly changing, numerical values should therefore be interpreted together with the degree of currency and uncertainty of the information.

For the Healthcare Disaster Manager, quantitative indicators therefore represent tools for monitoring the dynamic relationship between demand and capacity, recognising relevant changes, and supporting the potential adaptation of the response. Their value lies not in replacing professional judgement, but in making certain components of the scenario more observable and directing attention towards conditions that require reassessment.

4.5 Management of CBRNe Scenarios: Operational Complexity and Healthcare Coordination

Chemical, Biological, Radiological, Nuclear and Explosive (CBRNe) events represent scenarios characterised by specific healthcare, operational, and safety requirements. Their management may require the integration of clinical and specialist expertise with capabilities in risk assessment, personnel protection, and coordination among different organisations. However, the acronym encompasses heterogeneous events and does not identify a single response approach: the measures to be adopted must be defined according to the nature of the agent, the mode of exposure, and the characteristics of the scenario.

During the preparedness phase, advance risk assessment is particularly important, as it provides the basis for developing procedures, training personnel, and identifying the necessary resources. The World Health Organization's Red Book, addressing Emergency Medical Teams operating in armed conflict and other insecure environments, emphasises the need for specific preparedness measures in the presence of CBRNe risks, including training, protective equipment, procedures, and plans consistent with the findings of the risk assessment [76]. Although these recommendations refer specifically to the EMT context, they highlight the importance of integrating the CBRNe component into planning before an event occurs.

During the response phase, one of the initial requirements is to obtain sufficient information to characterise the hazard and guide initial safety measures. In this context, rapid-reference manuals and tools may be used alongside detection and identification technologies. The Emergency Response Guidebook (ERG), for example, is intended for first responders during the initial phase of transportation incidents involving hazardous

materials or dangerous goods and serves as a support tool for preliminary hazard identification and the identification of initial protective measures [75]. Its use should remain within the specific scope for which it was developed and does not replace subsequent specialist assessment.

Particular attention should be given to the protection of personnel and healthcare facilities. When indicated by the characteristics of the scenario, the management of contaminated individuals requires defined procedures to prevent personnel exposure and secondary contamination of healthcare facilities. Within its specific context of application, the WHO document provides for procedures for patient decontamination before admission to healthcare facilities, as well as for the decontamination of affected areas, equipment, and vehicles [76]. Decontamination should therefore not be regarded as a uniform measure applicable to every CBRNe event, but rather as an intervention to be determined according to the identified risk and specialist guidance.

The management of these scenarios also requires multidisciplinary and inter-organisational coordination [76].

For the Healthcare Disaster Manager, the relevant competency does not consist of replacing CBRNe specialists, but rather of understanding the organisational implications of the scenario, recognising which areas of expertise need to be involved, and facilitating the integration of specialist information into planning and response processes. CBRNe scenarios therefore demonstrate how managing complexity requires not the concentration of all technical knowledge in a single professional, but the ability to connect different professionals, information, and tools within a coordinated response.

4.6 Urban Search and Rescue (USAR) Scenarios: Integration Between Technical Rescue and Healthcare Response

Urban Search and Rescue (USAR) scenarios involve search and rescue operations in contexts characterised, in particular, by structural collapse and the presence of trapped individuals. Such scenarios require the integration of search activities, assessment of the operational environment, access to and extrication of victims, healthcare assistance, logistics, and management under conditions that may be characterised by structural instability, limited accessibility, and the presence of secondary hazards [67].

At the international level, an organisational reference is provided by the International Search and Rescue Advisory Group (INSARAG), a network operating within the United Nations framework. The INSARAG Guidelines establish shared principles for the preparedness, classification, and coordination of international USAR teams, with the aim of facilitating the coordinated deployment of teams from different organisations and countries [67]. Standardisation therefore concerns not only the operational capabilities of teams, but also the mechanisms through which these capabilities are integrated into the response to an event.

The healthcare component forms an integral part of this system. USAR teams comprise different functional components, including search, rescue, medical, logistics, and management [67]. Healthcare assistance must therefore be integrated with technical access and extrication activities, taking into account both the needs of victims and the protection of personnel involved in the operations. From this perspective, the rescue of an individual should not be regarded as a process separate from subsequent healthcare

management, but rather as one stage of a continuum of care that must extend to the emergency medical system and appropriate healthcare facilities.

In more complex events, particularly when multiple teams are operating simultaneously across numerous sites, information coordination becomes especially important. Within the INSARAG framework, the USAR Coordination Cell (UCC) serves as a coordination function for USAR teams and operates in conjunction with the other structures established by the system. The INSARAG Coordination & Management System (ICMS) supports this function through the collection, organisation, and representation of information relating to teams, operational sites, and ongoing activities [68]. ICMS documentation also demonstrates how the system can support site allocation and the establishment of operational priorities within the USAR coordination methodology.

The availability of digital tools does not, however, make priority setting automatic. Information relating to site conditions, team capabilities, and operational requirements must be interpreted within the established coordination structure. ICMS therefore provides a concrete example of how an information tool can support the response phase, provided that it is embedded within clearly defined procedures, roles, and responsibilities [67,68].

In this context, it is important to emphasise that the Healthcare Disaster Manager is not responsible for the technical command of USAR operations, nor does this role replace team leaders or the coordination structures established within the INSARAG system. Rather, their potential contribution lies in linking the healthcare needs generated by the scenario with the capacity of the healthcare network, facilitating continuity between the operational area, the emergency medical system, and healthcare facilities. Depending on the organisational arrangements adopted, this may include supporting healthcare planning, resource management, information flows, and pathways for victim evacuation and subsequent care.

USAR scenarios therefore highlight a broader principle of healthcare Disaster Management: tools, procedures, and specialist competencies become effective when they are integrated within a shared coordination structure. For the Healthcare Disaster Manager, the added value lies not in the specialist management of search and rescue activities, but in the ability to integrate the healthcare implications of the event with the other components of the response while preserving their specific roles and responsibilities.

Chapter 5: Operational Applications of Healthcare Disaster Management: Case Studies, Innovation and Future Perspectives

5.1 Case Study: Healthcare Planning for La Notte della Taranta

A concrete application of the healthcare planning principles discussed in the previous chapters is provided by La Notte della Taranta, an annual music festival held in Melpignano, in the province of Lecce, which attracts approximately one hundred thousand attendees. Zinnari and colleagues retrospectively analysed data provided by the 118 emergency medical service and the Italian Red Cross relating to six editions of the event, from 2006 to 2011, with the aim of assessing healthcare demand and comparing the resources deployed with those estimated using a quantitative planning model [70].

The analysis considered presentations to the Advanced Medical Post (Posto Medico Avanzato – PMA), the reasons for presentation, and the corresponding triage classification. Among the most frequently observed conditions were alcohol intoxication and traumatic conditions, particularly skin injuries and musculoskeletal trauma [70]. These findings highlight how healthcare planning for a Mass Gathering Event must consider not only the potential volume of demand, but also the types of healthcare needs that can reasonably be expected to arise.

A central element of the study was the application of the Maurer algorithm. Using the parameters considered by the authors and the average data from the six editions analysed, a risk score of 64 was obtained [70]. This value corresponded to an estimated requirement of 40 first responders on foot, five patient transport ambulances, four emergency ambulances, and three medically staffed units [70].

The authors subsequently compared this estimate with the resources actually deployed by the Italian Red Cross and the 118 emergency medical service. During the editions considered, 70 volunteers, three patient transport ambulances, four medically staffed ambulances, three physicians, and three nurses were deployed. The comparison showed substantial similarity between the estimate generated by the algorithm and the resources actually used, although differences were observed in the composition of the healthcare deployment. The analysis also indicated the need for two additional ambulances, one emergency ambulance and one patient transport ambulance, to improve healthcare coverage of the event [70].

The case highlights the relationship between quantitative models and organisational judgement. As discussed in section 4.3, an algorithm does not automatically determine the healthcare resources that should be deployed: it produces an estimate that must be considered alongside the characteristics of the event, the available data, experience from previous editions, and the resources that can actually be mobilised. A difference between the model's output and the actual organisational configuration does not therefore necessarily represent an error, but rather an element requiring critical analysis within the planning process.

Particularly relevant from this perspective is the availability of a historical data series. The study demonstrates how information collected across different editions can be used not only to describe what occurred, but also to guide the planning of subsequent events, reducing reliance on exclusively empirical decisions and promoting more rational use of resources [70]. The authors themselves attribute an important role to the analysis of

previous experience in developing an organisational model capable of reducing improvisation.

From the perspective of the Healthcare Disaster Manager, the case of La Notte della Taranta provides a concrete example of the transition from data collection to organisational decision-making: analysing observed healthcare demand, using predictive tools, comparing estimated resources with those actually deployed, and translating the findings into recommendations for subsequent planning. The value of the case study therefore lies not only in the application of the Maurer algorithm, but also in demonstrating a process in which data, quantitative modelling, experience, and organisational assessment jointly contribute to preparedness for a complex event.

5.2 Technological Innovation and Future Perspectives in Healthcare Disaster Management

The evolution of digital tools is expanding the possibilities for acquiring, integrating, and representing information relevant to emergency management. As discussed in Chapter 4, GIS, digital platforms, and decision-support systems can contribute to planning and response, provided that the information they generate is relevant to operational needs and sufficiently reliable [24,63]. Looking ahead, the value of innovation will therefore depend not merely on the availability of more advanced technologies, but on their effective integration into organisational and decision-making processes.

An area of growing interest is the use of Artificial Intelligence (AI) tools and advanced forms of data processing. In healthcare Disaster Management, these developments can be considered primarily in terms of their potential to enhance the analysis of complex information and support decision-makers. Their introduction does not, however, alter a fundamental principle already discussed in relation to Decision Support Systems: such tools provide information that can assist the decision-making process, but do not eliminate the need for critical interpretation within the context in which the decision is made [63].

Digital Twins are also of particular interest. These are dynamic digital models through which real-world systems and processes can be represented. In healthcare, their development has been proposed as a means of integrating data and simulating different operational conditions, although challenges remain regarding model development, validation, and transferability [64]. In healthcare Disaster Management, their potential applications may include exploring alternative scenarios and assessing the consequences of changes in demand or available capacity, while maintaining a clear distinction between scenario simulation and deterministic prediction of how an event will evolve.

The development of increasingly data-dependent tools makes information quality a central consideration. Accuracy, completeness, timeliness, and suitability for users' needs influence the usefulness of the outputs produced [65]. At the same time, the ability to integrate information from different systems depends on those systems being capable of exchanging and using data consistently, making interoperability an important requirement for the future development of digital tools applied to healthcare emergency management [66].

Increasing technological capability does not therefore automatically improve the quality of decisions. Indeed, the availability of greater quantities of information may increase the complexity of the interpretative process when data are not adequately selected and organised; the literature on information overload demonstrates how an excessive volume of information can hinder, rather than facilitate, information processing [23]. Innovation must therefore be accompanied by the ability to identify which information is genuinely relevant to operational needs.

From this perspective, the Human Factor remains central. As discussed in Chapter 2, decision-making under conditions of uncertainty and time pressure does not depend exclusively on the quantity of available data, but also on the ability to recognise meaningful patterns, interpret the context, and use experience to guide action [26,28]. Technological tools can expand the information available to decision-makers, but their contribution must be integrated with training, professional experience, and critical appraisal skills.

For the Healthcare Disaster Manager, technological evolution does not therefore imply the need to become an information technology specialist. Of greater relevance is the ability to understand the function of the tools being used, critically evaluate their outputs, recognise limitations arising from the underlying data, and communicate effectively with the technical professionals involved. Technological innovation can thus expand the possibilities for planning and decision support without replacing the professional and organisational responsibility of the decision-maker.

The future of healthcare Disaster Management can therefore be interpreted as a progressive integration of technological tools, information quality, and human capabilities. Innovation becomes valuable when it improves understanding of the scenario and supports more informed decision-making processes, while keeping at the centre the ability of both the system and its professionals to critically interpret the information available.

5.3 The Future of the Healthcare Disaster Manager: Professionalisation and Organisational Perspectives

The analysis developed in the previous chapters highlights how healthcare Disaster Management requires the integration of organisational, decision-making, interpersonal, and technical competencies within complex and interdependent systems. International frameworks identify core competencies relevant to emergency preparedness and management, but do not define a universally established and standardised healthcare professional profile that can be unequivocally associated with the role of the Disaster Manager [6–8,10]. The future perspective therefore concerns not only the consolidation of competencies, but also the progressive definition of the function and its position within healthcare organisations.

From this perspective, professionalisation should not be interpreted exclusively as the introduction of a new professional qualification. Rather, it involves defining recognisable functions, coherent training pathways, mechanisms for maintaining and assessing competencies, and sufficiently clear organisational relationships. Training and experience represent complementary components of this process, while assessment makes it possible to verify over time the ability to apply acquired competencies. These

aspects, examined in greater detail in the previous chapters, acquire their full significance only when they can be associated with a function that is effectively embedded within the organisation.

A central issue therefore concerns the organisational positioning of the Healthcare Disaster Manager. This thesis proposes that, under ordinary conditions, the role could be considered a cross-functional staff function providing strategic support to Healthcare Management, rather than an additional hierarchical level positioned above existing organisational structures. Such a position could facilitate integration among planning, preparedness, training, exercises, and the review of previous experiences, while maintaining a cross-functional perspective across individual organisational units. The Disaster Manager would therefore not assume the responsibilities specific to the different structures, but could contribute to integrating them in relation to emergency preparedness and management objectives. This configuration represents an organisational proposal formulated in this thesis and not a model uniformly established by the regulatory references or frameworks analysed.

The ordinary organisational position must be distinguished from the functional position assumed during an emergency. When a command and coordination structure is activated, the Healthcare Disaster Manager should not create a parallel chain of decision-making, but should operate within the system established by the organisation and for the specific event [17]. The function actually performed may therefore vary according to the nature, scale, and complexity of the scenario. Nevertheless, the presence of this role under ordinary conditions could provide an element of continuity: prior knowledge of plans, resources, vulnerabilities, procedures, and organisational relationships could be transferred to the response when the system is activated.

An exclusively hospital-based position would also be limiting in relation to the nature of healthcare Disaster Management. Complex events involve hospitals, community-based healthcare services, pre-hospital emergency medical systems, public health services, Civil Protection, technical rescue services, and other organisations [3,16,17]. The Healthcare Disaster Manager can therefore be conceived as a node within this network, aimed at facilitating integration among different components without replacing their respective responsibilities and competencies. This dimension appears particularly relevant during preparedness, when relationships and coordination procedures can be established before an emergency and subsequently used during the response.

This approach makes it possible to envisage a territorial and multi-level organisation of the function. Alongside designated roles within healthcare organisations, the establishment of a territorial network linked to a regional level could be considered, with the aim of promoting shared guidance, methodological consistency, integrated planning, and the circulation of experience. The territorial dimension would make it possible to maintain proximity to local characteristics and the resources actually available, while regional coordination could become particularly important during events affecting multiple areas or requiring capacities beyond those available locally.

A potential application of this hypothesis could be explored within the context of the Emilia-Romagna Region, assessing the territorial areas covered by the emergency medical system and the 118 Emergency Operations Centres as a possible organisational basis for structuring the healthcare Disaster Management function. Within such a model, territorial points of reference could contribute to preparedness and to coordination among hospitals, community-based healthcare services, and the emergency medical

system, while maintaining a functional connection with a regional level focused on shared planning, standardisation, and the coordination of issues extending beyond individual territories.

This hypothesis should not be interpreted as a description of an organisational structure currently formalised by the Emilia-Romagna Region, nor does it necessarily imply the introduction of a Disaster Manager for each 118 Emergency Operations Centre (Bologna, Parma, Ravenna). Rather, it represents a proposal to be subjected to subsequent organisational assessment, taking into account the actual structure of the regional system, the responsibilities assigned to healthcare authorities and emergency structures, as well as their relationships with the regional level and the Civil Protection system. Any potential model should above all avoid duplication and overlapping functions, integrating instead with existing responsibilities.

The sustainability of such a configuration would therefore depend on the clear definition of its mandate, responsibilities, functional relationships, and organisational interfaces. From this perspective, professionalising the Healthcare Disaster Manager means not only establishing which competencies this professional should possess, but also clarifying where those competencies can be exercised, with what responsibilities, and through which relationships with the other actors within the network. Defining the individual professional profile and defining the organisational structure thus become two complementary dimensions of the same process.

The future of the Healthcare Disaster Manager can therefore be understood as a transition from a role defined primarily through a set of competencies towards a recognisable organisational function integrated within the healthcare network. Its potential specificity would not lie in overlapping with existing technical, clinical, or managerial professionals, but rather in the ability to connect different perspectives across the various phases of Disaster Management. Within this configuration, the Healthcare Disaster Manager could contribute to linking preparedness, planning, response, and organisational learning, operating under ordinary conditions as a cross-functional role and, during emergencies, integrating into the activated command and coordination systems.

Conclusions

This thesis has analysed the role of the Healthcare Disaster Manager with the aim of identifying its characteristics, competencies, and potential functions within emergency and disaster preparedness and response systems. The analysis of the literature and key institutional references reveals a field characterised by the progressive structuring of competencies, but in which a universally defined and standardised healthcare professional profile has yet to emerge. Rather than being defined through a single professional qualification, the Healthcare Disaster Manager can therefore be characterised by the function performed in connecting knowledge, professionals, resources, and different organisational levels.

The complexity of healthcare emergencies makes an exclusively technical or clinical perspective insufficient. Disaster management requires planning and organisational capabilities, as well as Situational Awareness, Decision Making, adaptability, leadership, and the ability to operate within multidisciplinary and inter-organisational networks. The Healthcare Disaster Manager should not, however, be understood as a professional who concentrates all the competencies required for the response within a single role, nor as a figure hierarchically superior to the specialists involved. Rather, the potential specificity of this role lies in its integrative capacity: the ability to connect different competencies and facilitate their coherent application to the needs of the scenario, acting as a catalyst for the timely actions that the emergency system must undertake both before and during a disaster.

The development of this function requires an approach in which training and experience, both previously acquired and progressively developed through training activities, are regarded as equally important. Theoretical knowledge provides models and interpretative tools, while exercises and simulations enable their application under controlled conditions; operational experience contributes to the development of pattern-recognition and adaptive capabilities that are difficult to acquire through classroom-based education alone.

Professionalisation also requires competencies not merely to be declared, but to be observable, assessable, and maintained over time through coherent pathways of continuing education and performance assessment.

At the same time, the effectiveness of healthcare Disaster Management depends on the availability and appropriate use of tools supporting planning and decision-making. GIS, digital platforms, quantitative models, operational indicators, decision-support systems, as well as manuals, planning models, and operational procedures, can strengthen the effectiveness of Disaster Management activities across the different phases of the disaster cycle, both during planning and during operational response.

Increasing digitalisation opens up further opportunities, but does not alter the principle that tools support rather than replace the decision-making process. Data quality, the ability to interpret outputs, and an understanding of the limitations of models remain essential conditions for the appropriate use of technology. Even with the development of Artificial Intelligence and more advanced digital tools, the Human Factor therefore remains central: experience, professional judgement, and decision-making responsibility must be integrated with new technological capabilities rather than simply replaced by them.

The case study of La Notte della Taranta provides a potential model for healthcare planning, demonstrating concretely how historical data and quantitative models can contribute to the advance estimation of healthcare resources required for major events. Similarly, a brief analysis of the complex operational structures used in CBRNe and USAR scenarios highlights how tools and procedures can add value to the potential response when integrated with specialist expertise and supported by clearly defined coordination structures.

The analysis conducted in this thesis also suggests that the definition of Healthcare Disaster Manager competencies should be contextualised in relation to the position of this role within the organisations responsible for establishing it. Its organisational positioning must therefore also be considered. The proposal developed in this thesis characterises the Healthcare Disaster Manager as a cross-functional staff function providing strategic support to Healthcare Management, capable, under ordinary conditions, of contributing to preparedness while maintaining an interdepartmental perspective and facilitating integration among hospitals, community-based healthcare services, and the emergency medical system. During the operational phase, and therefore when an emergency scenario occurs, this role should instead be capable of integrating into the activated command and coordination system without generating a parallel decision-making structure.

This perspective could be further developed through a potential territorial and regional organisation of the function. Within the context of Emilia-Romagna, the territorial areas covered by the emergency medical system and the regional 118 Emergency Operations Centres could provide a basis for exploring an interconnected healthcare Disaster Management network. This hypothesis does not describe a model that is currently formalised, but rather constitutes an organisational proposal requiring further analysis in relation to regional governance, existing responsibilities, and the sustainability of its implementation. The underlying principle remains integration: any new function should strengthen connections among existing operational structures rather than create overlapping responsibilities or competing chains of command.

From this perspective, the Healthcare Disaster Manager can be interpreted as a node within the healthcare and inter-institutional network, capable of contributing to continuity between preparedness, response, and organisational learning. The value of this role lies not only in individual competencies, but also in the ability to apply them within a complex system by building relationships before an event, facilitating coordination during the response, and contributing to the transformation of experience into organisational improvement.

Nevertheless, the work undertaken also identifies areas requiring further investigation, including the definition of shared training pathways, competency assessment criteria, mechanisms for professional recognition, and organisational models applicable to different healthcare systems. These areas represent potential directions for the future development of this research. In particular, the proposal for a territorial and regional function would require specific studies to assess its feasibility, its relationships with existing structures, and its potential effects on preparedness and response capacity.

Overall, the study conducted in this thesis suggests that the professionalisation of the Healthcare Disaster Manager should not necessarily lead to the creation of a new professional title, but rather to the definition of a dedicated role capable of supporting professionals from emergency and healthcare settings. Developing such a professional

function requires the integration of competencies, training, experience, tools, and organisational positioning within organised response systems capable of preparing, coordinating, and learning.

From this perspective, the future challenge is not to eliminate the uncertainty that inevitably characterises disasters, but rather to build capable healthcare systems that, whenever possible, can anticipate such uncertainty and, when necessary, manage it, while consistently and systematically learning from experience gained in the field.

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