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Thesis

Use of Multi-Criteria Decision Analysis (MCDA) Tool for Decision Support in Cardiovascular Emergencies Management:

A Scoping Review

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Acknowledgment

First and foremost, I would like to thank God Almighty, My Parakletos, my guide and counselor, for granting me the strength, wisdom, and perseverance to complete this thesis. Without his grace, this accomplishment would not have been possible. May he take all the Glory.

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List of Abbreviations

ACS- Acute Coronary Syndrome

AHP- Analytic Hierarchy Process

CBR- Case-Based Reasoning

CVDs- Cardiovascular Diseases

DCE- Discrete Choice Experiment

DEA- Data Envelopment Analysis

EHR- Electronic Health Record

ELECTRE III- Elimination et Choice Translating Reality

FST- Fuzzy Set Theory

ICU- Intensive Care Unit

JBI-Joanna Briggs Institute

LMICS- Low- and Middle-income Countries

MAUT- Multi-Attribute Utility Theory

MCDA- Multi Criteria Decision Analysis

MI- Myocardial Infarction

PCC- Population, Concept, Context

PRISMA-ScR -Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews

PROMETHEE- Preference Ranking and Organization Method for Enrichment Evaluation

SAW- Simple Additive Weighting

SMART- Simple Multi-Attribute Rating Technique

TOPSIS- Technique for Order of Preference by Similarity to Ideal Solution

Summary

Rationale of the Study

Cardiovascular emergencies are major contributors to global mortality and require rapid clinical decisions. Traditional decision-making relies on clinical guidelines and physician experiences, which often lack flexibility, transparency, and involvement of patient preferences. The Multi-Criteria Decision Analysis (MCDA) tool provides a structured approach to support complex decisions by integrating diverse competing criteria. MCDA use in cardiovascular emergencies is not well studied; therefore, this study addresses this gap by conducting a scoping review of the literature on MCDA tools in cardiovascular emergency management.

Planning of the Study

This study used a scoping review methodology guided by the PRISMA-ScR and the Joanna Briggs Institute Manual. Literature published from 2015 to 2025 was identified in PubMed, Scopus, and Web of Science. The review included studies on adult patients with cardiovascular emergencies in hospital settings where MCDA tools were used to support clinical decision-making. Relevant studies were screened using inclusion and exclusion criteria, then systematically extracted and analyzed through qualitative thematic synthesis.

Results

Out of 59 identified articles, 6 met the inclusion criteria. The studies originated from China, Taiwan, Turkey, the Netherlands, and one multinational study. The major MCDA methods applied included analytic hierarchy process and technique for order of preference by similarity to ideal solution. Applications of MCDA were primarily used for risk-benefit evaluation and treatment prioritization, and the major decision criterion was survival outcome.

Conclusions

MCDA shows strong potential to enhance decision-making in cardiovascular emergencies by offering a structured, transparent, integrated, and evidence-based approach. However, challenges such as limited real-time use, data dependency, and underuse in low-resource areas hinder its adoption. Future efforts should focus on developing user-friendly digital tools, health workers training and patient involvement.

1. Introduction

1.1 Cardiovascular Emergencies: Definition and Epidemiology

According to the World Health Organization (2025), cardiovascular emergencies are emergencies of the heart and blood vessels that are acute and life-threatening. These conditions require immediate medical care. The most common diseases include heart attack or acute myocardial infarction, stroke, cardiac arrest, and heart failure. Identifying early symptoms and rapid medical management are very important to decrease death rates and to improve patient outcomes.

Cardiovascular diseases (CVDs) are the major causes of death worldwide. They account for about 20 million deaths in 2021. This shows that approximately 55,000 deaths per day, or one death every 1.5 seconds, are due to cardiovascular diseases. This makes them the leading global killers. In the year 2021, heart and circulatory diseases were responsible for about 10.5 million male and 9.6 million female deaths. The majority of these mortalities, consisting of over 80% resulted from heart attacks and strokes. Of these, one-third of the deaths occurred prematurely in individuals younger than 70 years. Globally, an estimated 640 million people are currently living with cardiovascular diseases, meaning that roughly 1 in 12 individuals is affected. The most prevalent conditions include coronary (ischemic) heart disease, which accounts for approximately 250 million cases, peripheral arterial disease, which accounts for 110 million cases, stroke, which accounts for 94 million cases, and atrial fibrillation, which accounts for 53 million cases in 2021.(British Heart Foundation,2025)

According to British Heart Foundation (2025), the global burden of the most prevalent cardiovascular diseases is very high. Coronary heart disease (CHD), which is also known as ischemic heart disease, is the most frequently diagnosed heart condition worldwide. It affects over 250 million people globally. Of these, approximately 145 million people are men, and 110 million people are women. In 2021, coronary heart disease was responsible for nine million deaths, which accounted for around 1 in 7 deaths globally. This makes it the leading cause of cardiac mortality worldwide. Before the COVID-19 pandemic, CHD had been the major cause of death worldwide for the past 30 years. In 2011, it became the primary contributor of premature

mortality or death before age 70, surpassing neonatal disorders, and continued this position until 2019, with the coronavirus pandemic becoming the leading cause of global death in 2020 and 2021. Another major heart and brain condition with a global mortality burden is stroke or cerebrovascular disease (CBVD). It is estimated that there are around 94 million stroke survivors worldwide. Of these, around 48 million are men and 46 million are women. In 2021, stroke was ranked as the third leading cause of death globally. It was the cause of approximately 7.3 million deaths worldwide, and it was responsible for one in nine deaths globally. It was also the third major cause of premature mortality worldwide in the same year. The other important heart and circulatory condition with high global burden is heart failure. It affects around 64 million people worldwide. The number of individuals living with heart failure has been steadily increasing in recent years.

The estimated number of individuals living with heart and blood vessel conditions has increased at a higher rate globally since 1993. Moreover, deaths from these conditions are expected to continue rising. Projections for the period 2025 to 2050 indicate a 90.0% increase in cardiovascular disease prevalence, a 73.4% rise in crude mortality, and a 54.7% increase in crude disability-adjusted life years (DALYs). The total number of cardiovascular deaths is anticipated to reach 35.6 million by 2050, up from 20.5 million in 2025. (Chong et al., 2024)

1.2 Types of Cardiovascular Diseases

There are various heart and brain conditions grouped under the general term "CVD." These include CHD, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, and congenital heart disease. CHD is caused by impairment of the vessels supplying blood to the heart muscle. Cerebrovascular disease results from problems affecting the blood supply to the brain. Peripheral arterial disease impairs circulation to the hands and legs. CHD is due to structural abnormalities of the heart that began at birth and cause difficulty in normal heart function. Blood clots that develop in the leg veins can migrate to the heart and lungs. This results in deep vein thrombosis and pulmonary embolism. Accumulation of fatty deposits within blood vessel walls can obstruct blood flow to the heart and brain. This leads to acute events such as a heart attack (myocardial infarction) and stroke. Strokes may also occur due to bleeding or blood clots within the brain's blood vessels. (World heart Organization, 2025)

1.3 Common Risk Factors of Cardiovascular Diseases

According to World Health Organization (2025), the primary behavioral risk factors that contribute to heart disease and stroke are unhealthy dietary habits, lack of regular exercise, psychological stress, excessive tobacco and alcohol use. These behavioral risk factors usually manifest as intermediate clinical factors such as elevated blood pressure, increased blood glucose level and abnormal lipid level indicating the increased likelihood of an upcoming heart attack, stroke, heart failure, and related complications. Evidence shows that lifestyle modifications such as quitting tobacco smoking, decreasing dietary salt intake, eating more fruits and vegetables, performing regular physical activity, and avoiding harmful alcohol consumption can significantly reduce the risk of cardiovascular disease. In addition to this, public health policies play a crucial role in encouraging and maintaining long-term healthy behaviors. This can be done by providing conducive environments that ensure access and affordability for implementing healthy life choices, as well as creating strategies to improve air quality and reduce pollution. As stated by Alradwan et al (2024), atherosclerosis, which is a major risk factor of CVDs, is illustrated in figure 1 below as it progress from early lesion formation to thrombotic events.

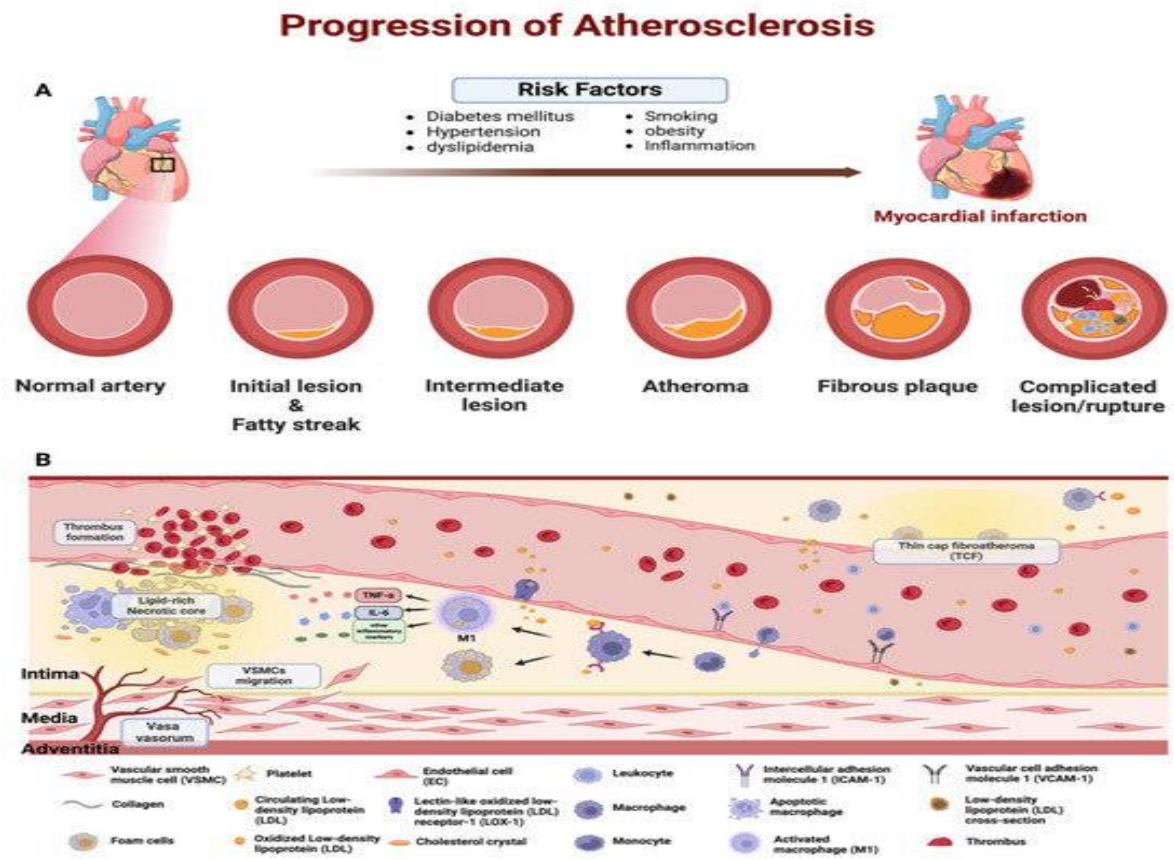

Figure 1. Schematic illustration of the progression of atherosclerosis. (**A**) The characteristic four pathological stages leading to the rupture of a complicated plaque lesion. (**B**) The development of atherosclerotic lesions involves the activation of macrophages and their subsequent foam cells, migration of smooth muscle cells (SMCs), and synthesis of extracellular matrix macromolecules such as collagen. Dead foam cells and SMCs form a lipid-rich necrotic core that presses on the endothelial cells creating thin cap fibro atheroma (TCF). Physical disruption of atherosclerotic plaque stimulates blood coagulation and ultimately results in thrombosis. (Reproduced from Alradwan et al., 2024, with permission)

1.4 Symptoms of Cardiovascular- Diseases

CVDs often progress silently, without showing symptoms in many individuals, until a major clinical problem arises. In many cases, a heart attack or stroke could be the first clinical manifestation indicating the presence of an underlying vascular abnormality. The symptoms of a heart attack include pain or discomfort in the chest, which may radiate to the arms, left shoulder, elbows, jaw, or back. Other symptoms an individual might experience include shortness of breath, difficulty breathing, nausea, vomiting, lightheadedness, fainting, excessive sweating, or pallor. In most cases, women present with shortness of breath, nausea, vomiting, and pain in the back or jaw more frequently than men. On the other hand, for cerebrovascular conditions like stroke, a person can experience symptoms like sudden weakness in the face, arm, or leg, which is usually confined to one side of the body, similar to the side of the brain affected. In addition to this, symptoms such as sudden numbness of the face, arm or leg of the same side of the body, confusion, difficulty in speech or comprehension, visual disturbances in one or both eyes, dizziness, difficulty walking, loss of coordination or balance, sudden severe headache of unknown origin, and in some cases, fainting or loss of consciousness could accompany the above presentations. Due to the severity of these conditions, immediate medical intervention is very crucial for individuals experiencing the above symptoms. (World Health Organization, 2025)

1.5 Management of Cardiovascular Diseases

World Health Organization (2025) explains that the management strategies for cardiovascular emergencies are tailored to the specific conditions of each clinical case. Individuals with heart and vascular diseases can present with various clinical warning signs such as chest pain or discomfort, palpitations, difficulty breathing, dizziness or light-headedness, and excessive sweating. Generally, management can be categorized into lifestyle modifications, pharmacological treatment, and surgical or interventional procedures. The most commonly prescribed medications to be taken orally include anticoagulants, aspirin, beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, and statins. In acute cases such as a heart attack or stroke, rapid medical intervention is crucial to save life. In some cases, surgical operations are required to treat cardiovascular diseases. These operations may use procedures such as coronary artery bypass grafting, balloon angioplasty (in which a catheter-mounted balloon is used to reopen blocked arteries), valve repair or replacement, heart transplantation, or

the use of artificial heart technology. Additionally, specific medical devices, such as pacemakers, prosthetic heart valves, and closure patches, can be used to manage cardiovascular conditions. As Stated by Singapore Heart Foundation, (2018), the primary cardiovascular disease management which is lifestyle modification is illustrated in the figure below.

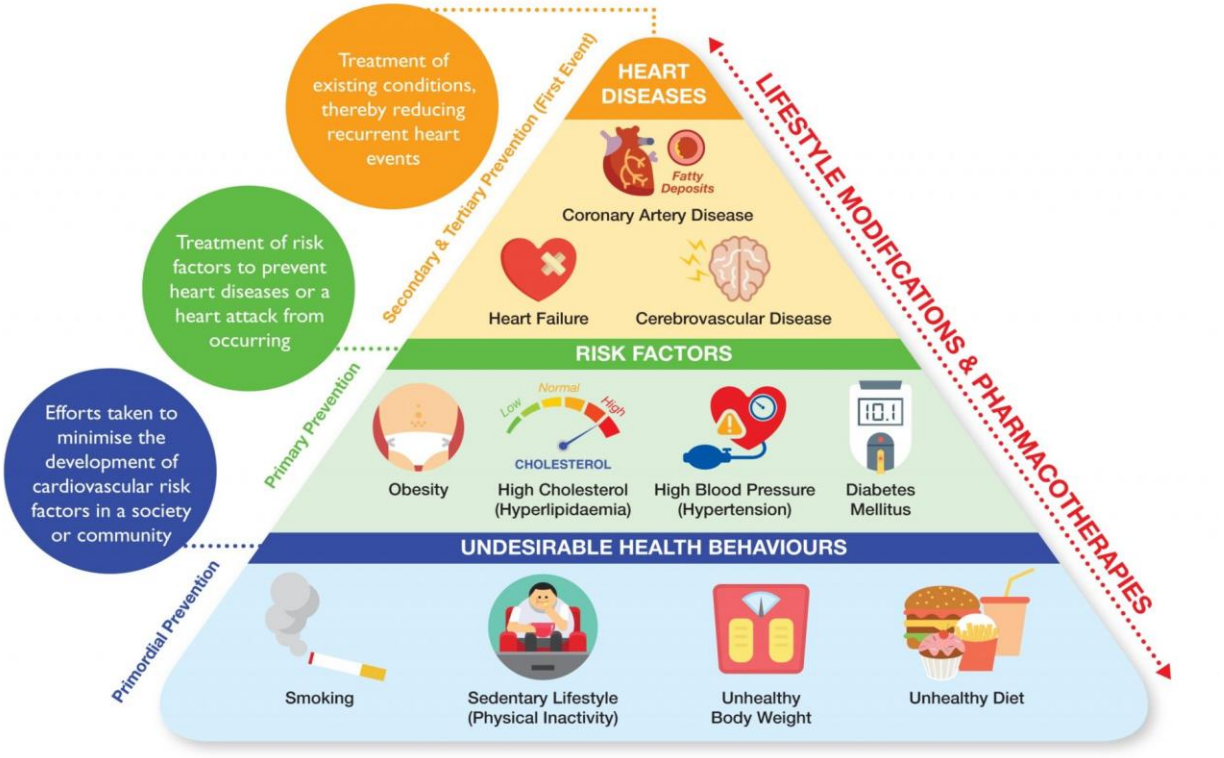

Figure 2. Lifestyle modifications and pharmacotherapies

(Reproduced by Singapore Heart Foundation, 2018, with permission)

1.6 Effect of Cardiovascular Disease in Low- and Middle-Income Countries

According to World Health Organization (2025), the effect of cardiovascular disease in low and middle-income countries (LMIC) is very significant. More than three-quarters of global cardiovascular-related deaths occur in these regions. The main reason contributing to this burden is the limited availability of primary health care services needed for the early detection and management of CVD risk factors. The other key challenge is inadequate access to effective and equitable health systems in LMIC. This results in late diagnoses and treatment of heart and vascular conditions that have already become more advanced disease stages. As a consequence of this, the late detection at an advanced disease stage causes most individuals in these regions to die from cardiovascular and other non-communicable diseases (NCDs) at their young and productive age, resulting in an economic burden on the nation. This has a severe impact, particularly among the nations with economically low populations, because it affects both the health and financial aspects of the regions, resulting in a major crisis. Evidence shows that cardiovascular diseases and other NCD contribute to poverty at the household and macro-economic level. At a household level, it causes high out-of-pocket expenditure, and at a macro-economic level because it places a heavy financial burden on the nation, killing the productive generation at a younger age. There are various competing priorities physicians face frequently during cardiovascular emergency management. These include the effectiveness of treatment choice, potential adverse outcomes, patient preference, resource limitations, and logistical challenges. These decisions are usually made under high pressure, with a restricted time period, and with incomplete information. The traditional decision-making approaches depend primarily on guideline-based protocols and physicians' clinical judgment. This approach is practical, but it often lacks adaptability to respond to context-specific conditions, and it could have difficulty balancing multiple decision criteria effectively. Therefore, the use of a structured methodology with a systematic and transparent decision-making framework is needed. It can combine various clinical considerations, such as survival probability, patient preference, and complication risks, to result in efficient cardiovascular disease emergency management.

1.7 Multi-Criteria Decision Analysis Definition

According to Gongora-Salazar et al (2023), Multi-criteria Decision Analysis (MCDA) can be defined as a formal, transparent, and flexible decision-making method that is applicable across many fields, including healthcare. MCDA also promotes cooperation among various healthcare stakeholders. MCDA can also be referred to as a structured method that is implemented to carry out comparative evaluations of numerous alternatives, like healthcare interventions, to their performance criteria. Building a quantitative MCDA involves several linked steps. It starts by simply defining the decision problem. It proceeds to select the appropriate evaluation criteria that fit every problem. The performance of every alternative is then weighed against every criterion, and relative weights are determined to reflect the importance of these criteria. The performance scores and relative weights are then multiplied to produce the total value of every option. Finally, after uncertainty assessment and control, the outcomes and conclusions are explained. By this systematic, step-by-step, and open-ended process, MCDA helps decision-makers synthesize different kinds of evidence and opinions into better-informed and better-balanced health care decisions in an orderly manner.

As explained by Drake et al (2017), MCDA is a value-focused evaluation approach that aims to address challenging decision problems by bringing in several factors and viewpoints through a transparent and rational framework. This method assists decision-makers in fragmenting complex problems into manageable, smaller sections and also illuminates the interconnections among these sections. Quantification of every section and combination of these quantifications to establish desired solutions is very important procedure in the MCDA process. MCDA also plays a crucial role in formulating and assessing the priorities and preferences of stakeholders and in establishing an explicit and transparent connection between subjective judgments and final decisions. In health care, a central concern among policymakers, clinicians, and patients is the absence of comprehensiveness and transparency, which is often noticed characteristic of decision-making processes. These limitations have stimulated increased interest in the use of MCDA, which has the potential to involve any criterion that the stakeholders state to be important. Moreover, MCDA identifies various institutional contexts and promotes an integrated, coherent, transparent, and flexible decision-making process. By structuring the choice and evaluation of alternatives, it allows evidence to be quantified in a rigorous manner, making it

easy to identify the most appropriate alternatives and reducing conflicts among stakeholders. Another advantage of MCDA is that it can potentially provide clearer signals earlier to the manufacturers, helping them to generate data more in line with decision makers' priorities.

1.8 Types of Multi-Criteria Decision Analysis

There are various well-established methods commonly used in Multi-Criteria Decision Analysis (MCDA). These include the Analytic Hierarchy Process (AHP), Multi-Attribute Utility Theory (MAUT), Simple Multi-Attribute Rating Technique (SMART), Fuzzy Set Theory (FST), Data Envelopment Analysis (DEA), Case-Based Reasoning (CBR), Simple Additive Weighting (SAW), Elimination et Choice Translating Reality (ELECTRE), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), and Goal Programming (GP). These MCDA approaches are adopted and effectively applied to the specific situations of various fields, including information and communication technologies, particularly for solving complex decision-making problems. (Zyoud & Fuchs-Hanusch, 2017).

As stated by Glaize et al (2019), among the listed MCDA methods, some are prominent and extensively used. The AHP analyzes challenging decision problems in hierarchical structures through systematic pairwise comparison of criteria and alternatives. The TOPSIS ranks and selects alternatives based on how close they are to an ideal solution. MAUT employs utility functions to represent and quantify decision-makers' preferences. PROMETHEE and ELECTRE belong to the outranking family approaches, which are especially useful in handling complicated ranking and prioritization problems.

As outlined by Belton and Stewart (2003), MCDA techniques can be generally grouped under three main categories: value-measurement models (which are normally referred to as compensatory methods), outranking methods (which analyze the dominance of one option over the other), and goal or reference-point approaches (where performance is compared by deviations from defined goals). In addition to these families, other frameworks and models have also been created and applied by researchers to assess value based on several, often conflicting, criteria. While these do not fit neatly into the three major families, their incorporation in MCDA remains essential to provide flexible decision assistance.

1.9 Use of Multi-Criteria Decision Analysis in Decision Making

Hummel and Ijzerman (2009) studied the use of AHP in various healthcare contexts, including policymaking (to enhance healthcare policy), the pharmaceutical sector (for evaluation of new drugs and medical devices), clinical practice (for developing new guidelines), and patient-focused settings (for incorporating patients' perspectives into decision-making). Collectively, these articles explored various uses of MCDA, focusing on specific context considerations, selected process steps, or a single methodological approach.

In a broader review, Marsh, Lanitis, Neasham, Orfanos, and Caro (2014) conducted a wide literature review that provided overall guidance on MCDA implementation. Their review involved different contexts and addressed important issues such as the types of MCDA methods frequently used, intervention performance assessment approaches, the selection and weighting of criteria approaches, and handling uncertainty in the reviewed studies.

In recent years, the application of MCDA techniques to address real-world complex decision problems has been growing at an increased rate. The timeline shows that there is an increased need to develop more advanced decision-support models that are effective in dealing with complex and dynamic issues. MCDA methods are now being combined with intelligent and expert systems, geographic information systems (GIS), and other advanced computer programs in order to enhance the effectiveness of decision-making. Two of the most widely applied MCDA methodologies employed in recent studies and applications are the AHP and TOPSIS (Glaize et al., 2019).

1.10 Applications of Multi-Criteria Decision Analysis in Healthcare

Various MCDA methods and tools are applied in the health field to support comprehensive decision-making tasks. A few examples include emergency management, diagnostic evaluation, first-stage health technology assessment, and benefit–risk comparison in infectious disease prevention and water carriage safety. MCDA is also applied to inform healthcare policy decision-making, support prioritization of surgical patients for surgery, evaluate treatment alternatives, and support shared decision-making in elective medical treatment (Broekhuizen et al., 2015).

According to Glaize et al., (2018), the main objective in applying a MCDA instrument is to encapsulate a set of usually conflicting criteria formally within a systematic framework that makes the identification of the optimal alternative easier. However, it has also been observed that decision-makers utilize MCDA not only for the final decision-making but also at the initial stage of the process. This occurs for various reasons, including offering psychological ease by validating intuitive conclusions, offering effective tools of communication, and using analytical data to defend or justify conclusions. Based on the ISPOR Task Force, there is a sharp distinction between decision-makers, the individuals who actually make the decisions, and stakeholders, who have values and preferences. The selection of stakeholders varies across studies and depends on the nature of the decision problem being addressed. In policy-making settings, representation of a diverse set of stakeholders with varying backgrounds and perspectives has been considered vital. Studies indicate that stakeholder selection must prioritize expertise and objectivity. In the discipline of Health Technology Assessment (HTA), the application of MCDA has a different goal. Here, the goal is to surpass the shortcomings of conventional HTA approaches by integrating the systematic MCDA. As a result, investigators find it appropriate to involve healthcare professionals so they can benefit from their knowledge and procedural experience. On the clinical and hospital levels, MCDA is an explicit, understandable, and reproducible decision-making framework. Encouraging heterogeneity between stakeholders is particularly valued to ensure that all interested participants who are likely to implement or reproduce the process in the future are adequately represented. Several studies conducted their analysis at the patient level, emphasizing the inclusion of patients' opinions in the decision-

making process. These studies indicated that patients express a high interest in engagement and should be more frequently involved in such processes. Covariant to all the studies herein reviewed is the requirement to define alternatives and criteria clearly and make such information accessible to all stakeholders. There must be an understanding among the participants regarding the MCDA framework and criteria employed, lest conflict and misinterpretation erode consensus. The availability of clear and precise definitions helps minimize ambiguity and duplication of alternatives and criteria. Future research could explore the role of stakeholder training in MCDA procedures. As Koch and Rowell (1999) have argued, the issue of whether stakeholders, particularly committee members, must be formally trained or whether it is the role of the facilitators to pass on MCDA procedure knowledge remains to be open question.

As observed by Dehe and Bamford (2015), the greatest obstacle in applying MCDA is the lack or inconvenience of access to good information that can be applied when making decisions. These not only complicate the analysis, but they also add an enormous level of bias to the results. The second major impediment encountered was the difficulty in getting all stakeholders into one room. The authors actually explained that serious computation and analysis became feasible when the stakeholders worked collaboratively in an environment that was based on mutual cooperation and trust. The issues should be addressed so that they can be resolved systematically throughout the MCDA process. Most of the studies provided non-convincing arguments for choosing one MCDA method over another when deliberating on the method choice. Rather than presenting explicit justification, most authors stressed offering comments on the accomplishments and problems encountered during implementation. In one study, the AHP was particularly helpful as it facilitated quantitative measurement of group decision-making through pairwise comparisons. Another study cited that a structuring of smaller working groups facilitated participants' ability to discuss more easily and more effectively. Conversely, in a single paper, it had been argued that the Discrete Choice Experiment (DCE) approach was too cognitively demanding and hence not accessible to all interested parties due to the cognitive burden of completing questionnaires and interpreting the results. Although these frank comments are beneficial to future researchers and decision-makers, in the studies reviewed, they typically did not discuss, albeit implicitly, how the character of the decision problem informed the selection of the most appropriate MCDA approach. Recent recommendations made by the ISPOR Task Force indicate that the first and foremost step in any MCDA model is to state and

define the decision problem briefly, as this prevents any bias and refrains from misusing methodology. According to this principle, the current study places specific emphasis on the function of problem identification as an initial step in the MCDA process, which not only clarifies the decision context but also legitimates the choice of analytical technique. Finally, a review of 70 random studies confirmed the positive impact and practical applicability of MCDA in medical decision-making. The study demonstrated that the output of MCDA can be used effectively to reinforce new decisions or validate existing ones by enhancing the completeness, structure, and clarity of the whole decision-making process.

A study emphasized that MCDA needs to be employed as a facilitating instrument and not as a rigid formula in the support of stakeholders in decision-making and acceptance. The value of MCDA methods was valued for several reasons. At the methodological level, researchers consistently understood that MCDA provides transparency, structure, and analysis rigor and generates more rational and systematic prioritization. Overall, the application of MCDA throughout healthcare uses has been characterized as effective and efficient in improving decision-making. Another study went even further in suggesting that MCDA structures employ simple and intuitive methods so that stakeholders could be concerned with weighting and scoring attributes but not with the complexity of the model behind. From the data collection perspective, MCDA is most valued for its comprehensiveness, in the sense that it allows subjective opinion and imposes no limitations on the volume or kind of criteria to be included. For the stakeholders, there has been a uniformly positive early response to the MCDA process. The strategy enhances communication and collaboration among stakeholders through the sharing of views, opinion, and interpretations with regard to the decision problem. The stakeholders thereby become more confident and engaged in the process, and resulting decisions become more readily available and easier to interpret as meaningful and warranted (Glaize et al., 2018).

1.11 Role of Multi Criteria Decision Analysis in Cardiovascular emergencies

According to Gongora-Salazar et al (2023), MCDA is an important instrument in the treatment of cardiovascular emergencies, especially in making time-sensitive and life-or-death decisions. Often, its primary application is in patient prioritization (triage), wherein MCDA enables the physician or decision-maker to systematically consider various criteria such as the severity of symptoms, likelihood of recovery, and available medical facilities to provide the necessary focus point to those with the most urgent needs. In resource-scarce or high-pressure situations, i.e., patient surges, MCDA supports the necessary allocation of the limited resources, such as hospital beds, healthcare personnel, and critical devices, by combining resource allocation with patient needs and expected clinical outcomes. In addition, MCDA supports treatment decision-making by making sure that there is an orderly process of evaluating various treatment alternatives along several dimensions such as clinical efficacy, safety profile, cost-effectiveness, and patient preference. The proper process of assessment results in evidence-based and knowledgeable clinical decisions. Besides the treatment of individual patients, MCDA helps in forming treatment standards for cardiovascular emergencies, so that it increases treatment homogeneity as well as treatment quality. MCDA also plays a role in emergency preparation and planning by helping identify systemic vulnerabilities and risks and forming strategic decisions like the appropriate allocation of staff or providing necessary medical equipment. For example, in acute myocardial infarction or heart attack, MCDA can help prioritize reperfusion treatment in patients based on weighing factors like the time of the start of the symptoms, complications, and patient risk information. The integration of MCDA into cardiovascular emergency management has several important benefits. It increases decision quality by introducing a clear methodology and reducing subjective clinical judgment. The systematic process allows health professionals to generate consistent, rational, and fact-driven decisions within time constraints. Additionally, MCDA maximizes the use of limited healthcare resources such as healthcare staff, equipment, and intensive care beds by imposing decision-making against a wide range of established criteria. Ultimately, this leads to increased patient outcomes, as timely and effective interventions are focused on those in need the most. Besides, transparency inherent in the MCDA process strengthens accountability among medical practitioners and builds trust with patients, families, and communities.

1.12 Limitations and Challenges

Oliveira et al. (2019) identify a wide range of recurring limitations and challenges associated with the application of MCDA in HTA. These include issues related to how evidence and data are managed when constructing and applying models, difficulties arising from variations in stakeholders' value systems, and the impact of group size and composition on evaluation outcomes. Challenges also stem from participants' limited understanding of both the modeling process and the interpretation of its outputs. Additionally, model developers often struggle to balance methodological rigor with the constraints of time and financial resources. Further concerns involve the selection of appropriate criteria and the definition of measurable attributes, the treatment of uncertainty, and the handling of additive assumptions within models. The choice of analytical methods, the processes used to build consensus and combine stakeholder judgments, and efforts to develop generalized evaluation frameworks also present obstacles. Finally, there remains a significant need for training and expertise in MCDA, as well as for developing scoring systems that convey results in a clearly interpretable and meaningful way.

1.13 Knowledge Gap

Despite MCDA's potential, real-world utilization, benefits, limitations, and outcomes of MCDA in cardiovascular emergencies have not been systematically reviewed. Understanding its current applications is needed to inform future research, guide clinical integration, and help develop standardized MCDA-based tools for emergency care.

2. Objective of the Thesis

The main objective of this thesis is to assess and evaluate the use of MCDA tools for decision support in cardiovascular emergencies management through a scoping review of the literature published between 2015 and 2025.

The specific objectives of this thesis are stated as follows;

- To recognize the various MCDA methodologies in cardiovascular emergencies that has been used in clinical decision-making and patient management.
- To assess the particular clinical scenarios and the perspective of decision-making in which MCDA has been applied, such as triage, treatment prioritization, risk and benefit analysis, and critical resource allocation.
- To identify existing challenges, limitations, and barriers to practically implement MCDA in the cardiovascular emergency management setting.
- To provide recommendations for future research to improve the practical adoption and integration of MCDA tools within cardiovascular emergency care systems.

3. Methodology

In this study, a systematic and comprehensive step-by-step procedure is followed to allow the appropriate methodology for scoping review. So that a research question and objective are defined, a comprehensive literature search is done, studies are selected based on inclusion and exclusion criteria, data is extracted, and findings are summarized. For this purpose, the JBI (Joanna Briggs Institute) protocol is chosen for scoping review, the PCC (Population, Concept, Context) framework is used for defining the research question and inclusion criteria, and the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines are applied for transparent reporting. Each stage, from search strategy development to thematic analysis, is conducted to allow a clear mapping of existing information, identification of knowledge gaps, and synthesis of relevant findings on the use of MCDA tools in cardiovascular emergency management.

3.1 Study Design

This study used a scoping review study design, which is a well-known method to systematically map and synthesize research study findings on a selected topic of interest. Unlike systematic reviews, which aim to answer focused questions about the effectiveness of interventions, scoping reviews are exploratory in nature and are particularly useful when the existing literature is diverse, emerging, or complex. For this study context, a scoping review is selected to academically search the application of MCDA tools in the management of cardiovascular emergencies, a topic that is known for heterogeneous study designs, various clinical contexts, and different decision-making frameworks.

Scoping reviews are very important to identify knowledge gaps, summarize key concepts, and inform future research and clinical practice guidelines. The study design followed the JBI methodology protocol for scoping reviews, which provides a structured approach to conduct such reviews and emphasizes transparency and reproducibility. Additionally, the Preferred Reporting Items for PRISMA-ScR checklist were used for reporting of results to make it systematic and comprehensive. The combination of the JBI Protocol and the PRISMA-ScR checklist will strengthen the reliability and academic validity of the review.

Formulation of the Research question and Use of the PCC Framework

The identification and definition of this study question used the PCC framework, considered more suitable for exploratory studies of similar scoping reviews. Application of the PCC framework ensures the review question is inclusive and comprehensive, enabling a wide exploration of literature without the limiting focus on intervention and outcome.

• Population P: The review targeted adult patients who present with various forms of cardiovascular emergencies, such as ACS, myocardial infarction, cardiac arrest, and life-threatening arrhythmias. Also included were hypertensive crises that precipitate acute cardiovascular complications, as well as stroke secondary to cardiovascular causes, including embolic strokes secondary to atrial fibrillation. These patients, therefore, present populations that are at critical, time-sensitive conditions requiring rapid and complex clinical decision-making and urgent clinical management.

• Concept: The major concept targeted in this study is the application or evaluation of MCDA tools in clinical decision-making of cardiovascular emergencies. MCDA tools are basically decision-making approaches with structured frameworks that incorporate multiple criteria to support clinicians in choosing strategies for managing complex cases. This includes techniques such as AHP, PROMETHEE, ELECTRE, or other multi-criteria decision-making techniques and methods devised to enhance clinical judgments and prioritize interventions in acute clinical scenarios.

• Context (C): Studies included in this review are conducted in a hospital-based setting that involved emergency departments, ICUs, cardiology wards, and tertiary care centers that manage complex cardiovascular emergencies. Hospital-based care is the focus to ensure that the review document relevant information on how MCDA may be of practical implementation in real clinical environments where structured decision-making tools can have immediate and significant impacts on patient outcomes.

By complying the research question with the PCC framework, the study has a systematic and transparent approach to identifying relevant findings and obtaining important information about the applications, benefits, and limitations of MCDA tools in cardiovascular emergencies.

3.2 Eligibility Criteria

Inclusion Criteria:

The inclusion criteria are intended to specify the relevance and quality of the studies to be included in this study. These were formulated in accordance with the above-mentioned framework of PCC:

• Population: Adult patients, aged above 18 years, suffering from any of the cardiovascular emergencies

• Concept: Reviews of MCDA methods applied to or tested in cardiovascular adult patients, including but not limited to frameworks like AHP, PROMETHEE, or other structured multi-criteria decision-making tools.

• Context: Hospital-based care, including emergency departments, ICUs, cardiology wards, and tertiary care centers managing advanced cardiovascular emergencies.

• Languages: Articles published in English only, which were selected to ensure a clear and accessible analysis was done.

• Type of Publication: Peer-reviewed journal article; between 2015 and 2025; application of MCDA to cardiovascular emergencies.

Exclusion Criteria:

Exclusion criteria are set for the studies that are not relevant to the focus of the review:

• Population: The studies that target pediatric populations.

• Factor-Concept: Investigations about decision-making methods or tools other than MCDA.

• Setting: Community-based studies, which are performed outside the healthcare facilities.

• Languages: Non-English Publications

• Type: Non-peer-reviewed literature includes conference abstracts and editorials or commentaries.

3.3 Search Strategy

A comprehensive and systematic search strategy is developed to identify all relevant existing literature on the topic of interest. The search is conducted across three major academic databases: PubMed, Scopus, and Web of Science. These academic sources are chosen for their broad coverage of biomedical, clinical, and health management literature.

The search strategy combined keywords and synonyms using Boolean operators to maximize sensitivity while maintaining specificity. The following search string is used:

("multi-criteria decision making" OR "multi-criteria decision analysis" OR "MCDA" OR "MCDM" OR "multi-attribute decision making") AND ("cardiovascular emergencies" OR "acute coronary syndrome" OR "cardiac arrest" OR "stroke" OR "myocardial infarction") AND ("decision-making tools" OR "decision analysis" OR "triage" OR "healthcare decision support")

Additionally, the reference lists of all included studies are hand-searched to identify further relevant articles not captured by the database search and to enhance the comprehensiveness of the study review, and to align it with the JBI Protocol.

3.4 Study Selection

Study selection was performed by the student author under the guidance of the academic co-mentor. When uncertainties arose cases were discussed with the academic co-mentor and were resolved through consensus. The study selection was done through two processes:

1. Title and Abstract Screening: All the retrieved records from the mentioned academic sources are screened to contain key words and concepts of the study review in the title and abstract, so that studies irrelevant to the research question could be excluded.

2. Full-text screening: Full-text articles of the potentially eligible studies are assessed against the predefined inclusion and exclusion criteria.

The PRISMA-ScR flow diagram is used to present the number of studies identified, screened, excluded, and finally included in the review. This visual representation creates transparency and hence enhances reproducibility.

3.5 Data Extraction

In this study, to extract data from the screened literature sources, a standard data extraction form is developed according to the JBI Scoping review guideline. The extracted data included: Author(s) and year of publication, country and clinical setting, type of MCDA method used, Decision criteria considered, reported outcomes, benefits, and challenges of applying MCDA tools. The data extraction is conducted by the student author following the JBI scoping review guideline.

3.6 Data Analysis and Synthesis

Synthesis findings are done across the screened studies using a qualitative thematic analysis. This involved identifying recurring patterns and concepts used for the application of the MCDA tool in cardiovascular emergency management. Themes are developed that describe: the practical applications of MCDA tools in clinical decision-making; benefits in using MCDA tools for prioritizing interventions, reducing decision-making errors, and optimization of patient outcomes; challenges and limitations in implementation; knowledge gaps and areas for future research.

The analysis is made up of narrative and descriptive parts, consistent with the purpose of scoping reviews. The results are supposed to provide a comprehensive overview of the relevant findings rather than being quantitatively described.

3.7 Ethical Considerations

As this study involved only the synthesis of published existing literature and did not include human participants, formal ethical approval is not required. Nevertheless, all studies are analyzed and reported in accordance with ethical principles, and proper attribution is given to all original sources.

4. Results

For this study, to increase transparency in reporting scoping review I followed the PRISMA-ScR framework (Tricco et al., 2018). This checklist guides the presentation of essential reporting items, including the study selection process. The following PRISMA-ScR flow diagram summarizes the identification, screening and inclusion of the studies in this review.

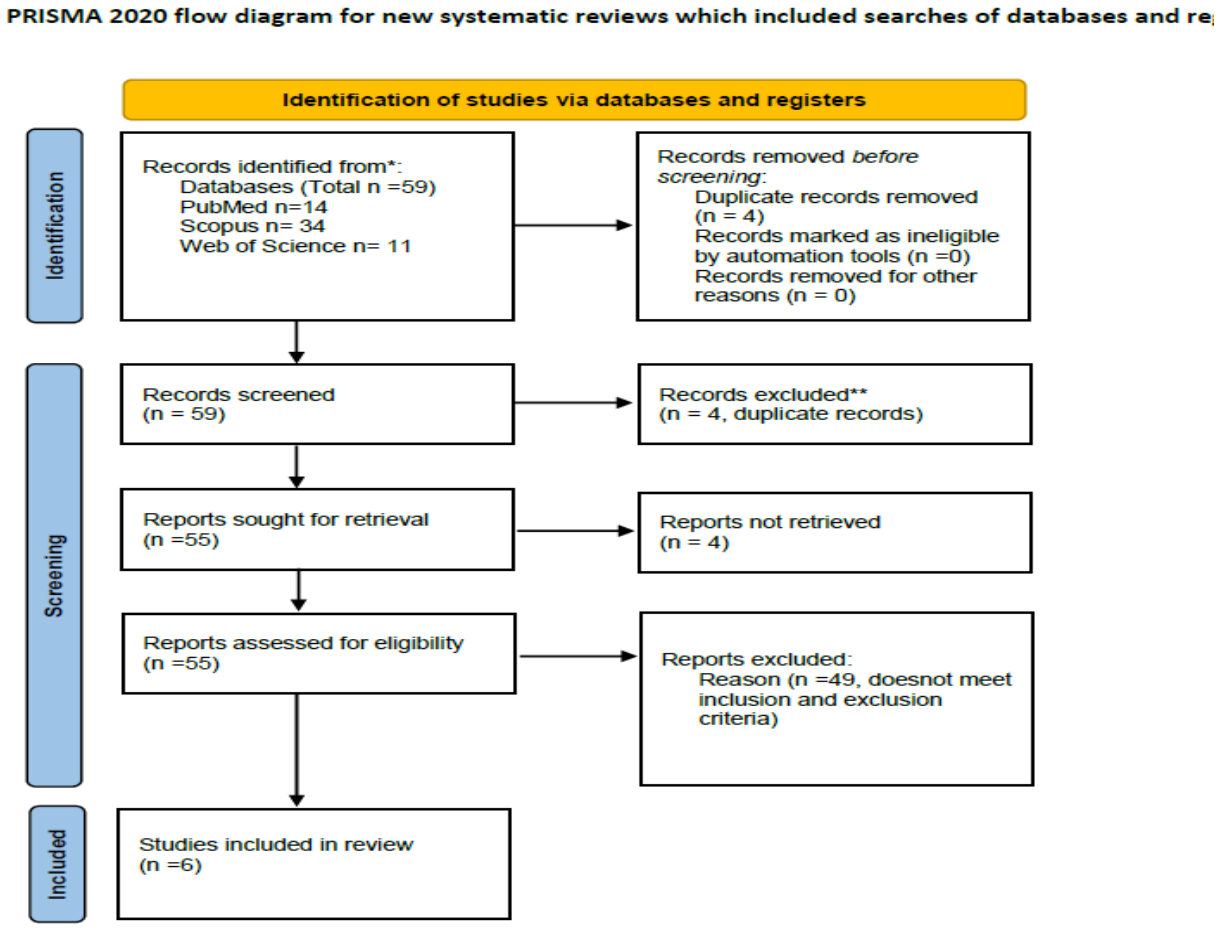

Figure 3. PRISMA-ScR Checklist flow diagram which includes searches of databases

A total of 59 articles are identified from the databases; PubMed, Scopus and Web of Science. After Title, Abstract and full-text Screening, 6 articles are included in this study.

The geographic distribution of the six articles included in this study encompasses China, Taiwan, Turkey, the Netherlands, and one multinational study conducted across several European countries and Canada. The MCDA types, applications, decision criteria, and the benefits and challenges of using MCDA tools for each geographic area represented in the included articles are shown in the tables below.

Table 1: shows the geographic distribution, MCDA types, applications and decision criteria used in the included articles for this study.

Article	Country or Region	MCDA type (AHP, TOPSIS,PROMETEE, Hybrid or other)	MCDA Application settings (Treatment prioritization, Diagnosis support, Triage decision, resource allocation, Risk-benefit evaluation)	Decision Criteria (Clinical severity, survival outcome, resource availability, patient preference, risk-benefit)
1	China	AHP	Diagnosis support	Survival outcome
2	Taiwan	TOPSIS	Treatment prioritization	Survival outcome
3	Multinational	Hybrid	Risk-benefit evaluation	Survival Outcome
4	Turkey	ELECTREE 3	Treatment prioritization	To reduce Clinical severity
5	Taiwan	Additive Weighted Scoring method	Risk-benefit evaluation	Risk-benefit
6	Netherland	AHP	Risk-benefit evaluation	Patient preference

The above table is explained in this section. The first MCDA method is AHP (Analytic Hierarchy Process), and it is used in China and the Netherlands. In China, AHP is used to assist in diagnostic decision-making by weighing clinical factors associated with survival outcomes, a typical goal in oncology and decision-making in critical care. In the Netherlands, AHP is used for risk-benefit analysis with special emphasis on the articulating patient, as this aligns with the country's emphasis on a patient-centric approach and shared decision-making. Another MCDA method, TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), is used in Taiwan to facilitate the ordering of treatments with a focus on maximizing survival. This corresponds with Taiwan's goal of maximizing clinical outcomes associated with its national health insurance system. A Hybrid MCDA method is used in a multi-country study, integrating several MCDA methods to assess the risk versus benefit in different global contexts. The focus on survival outcomes as a criterion for contradictory decision making underscores its importance in medical decision making. Method III of ELECTRE, which is one of the outranking methods, is used in Turkey for treatment prioritization, assigning the clinical severity as the main decision axis. This shows an intention to ease the burden of the disease in an efficient manner in resource-scarce settings. Finally, in Taiwan, for the risk-benefit analysis of health interventions, Additive Weighted Scoring, which is a straightforward, transparent, and intuitive approach, is used, and the risk values as the main emphasis. This shows a need for decisive and straightforward measures for rapid clinical environments.

Each MCDA analysis focused on different decision criteria reflecting locally set public health objectives and the prevailing means in the area. One of these criteria is Survival Outcome. It is highly emphasized in China and Taiwan, and the international study, reflecting the universal attention given to the duration of life. Another is Clinical Severity. It is used in Turkey and demonstrates the effort to deal with the burden of disease or the early management of higher-risk patients. Another is the Risk-Benefit Ratio. It is used in the Taiwan study with additive scoring, indicating the attention to safety and the economic price of the treatment offered. The last criterion is Patient Preference, which is observable in the highest degree in the Dutch study, where the emphasis is on the changing ethics of healthcare and the importance of the framework of shared decision-making.

Table 2: shows the geographic distribution, the benefits and challenges of applying MCDA tools in the included articles for this study.

Article	Country or Region	Benefits of applying MCDA tools	Challenges of applying MCDA tools
1	China	Improved decision quality	Limited data availability, insufficient clinical training
2	Taiwan	Improved decision quality, accessible and easy to use, multiple stakeholder collaboration	Variable data quality, insufficient training
3	Multinational	Improved decision quality, multiple stakeholder collaboration	Sensitivity to input data
4	Turkey	Applicability and adaptability, improved decision quality, enhanced transparency	Different stakeholder perspective causing resistance
5	Taiwan	Effective treatment outcome, easy applicability, improved decision outcome	Insufficient familiarity of the tool
6	Netherland	Easy applicability, improved decision quality, effective treatment outcome	Limited real time usability

5. Discussion

The scoping review analyzed six studies that used different MCDA techniques across multiple geographic locations. The research studies originated from multiple countries, including China and Taiwan and Turkey, the Netherlands, and also included a multinational study between Europe and Canada. The research studies took place mostly in Asia since 66% of them took place there. The MCDA techniques which received the most use were AHP (Analytic Hierarchy Process) and TOPSIS and ELECTRE III and additive weighted scoring, and hybrid models. The MCDA methods found three main applications in risk-benefit evaluation, and two studies focused on treatment prioritization, and one study used the methods for diagnosis support. Different research studies used different decision criteria, which examined survival results and clinical severity and risk-benefit assessment, and patient preferences. Through their research, the studies showed MCDA functions as an effective tool to manage complex healthcare decisions in various medical settings.

As it is described by Gongora-Salazar et al. (2023), the classic decision-making process in cardiovascular emergencies usually depends on standard clinical guidelines, risk stratification tools, expert judgment, and often consensus-based opinions. While these approaches are widely used to manage urgent cardiac cases, they face notable limitations, especially when there are ethical issues, limited resources, and competing clinical priorities involved. Traditional methods usually give priority to one or two primary variables, such as urgency level or probability of survival, and physicians rarely provide detailed justification for their choices, making later review or modification difficult. Furthermore, traditional decision-making processes focus mainly on clinician experience but overlook systematic consideration of patient values and context-specific environmental factors. By contrast, MCDA provides a more structured and flexible tool that allows openness in decision-making. Various MCDA techniques use diverse weighted criteria, which include clinical severity, patient preferences, resource constraints, and risks versus benefits considerations. With this approach, MCDA produces clear documentation to support transparency in different care teams and healthcare locations. The framework can also be used to fit various population needs, local conditions of care, and particular emergencies. MCDA becomes very important in this regard in emergency resource allocation, where decisions for fair distribution of resources are to be made as quickly as possible. The key strength it provides is combining both quantitative metrics and subjective judgments to allow clinicians to

consider multiple aspects of patient care rather than being dependent on single determinants of decision-making. It also allows ethically based decision-making in a time of scarcity while reducing psychological burden by aligning practice with predefined decision criteria. Additionally, MCDA encourages collaboration among clinicians, patients, and policy stakeholders, increasing shared decision-making in urgent care contexts. Models such as the Analytic Hierarchy Process (AHP) and hybrid MCDA approaches demonstrate strong applicability across varied healthcare systems and geographic environments. However, traditional decision strategies still hold advantages in situations requiring immediate action, such as cardiac arrest, where rapid, straightforward decision-making is critical. The practical benefit of MCDA becomes most evident when integrated into real-time clinical decision support systems with simplified workflows, improving decision-making quality without compromising response times in emergencies.

MCDA is sensitive to the information or data it gets because the accuracy of results depends mainly on high-quality input, which is usually not similar across different regions and healthcare systems. Another challenge arises from the intrinsic subjectivity and the possibility of potential bias present in some MCDA approaches, such as the Analytic Hierarchy Process (AHP), which depend on expert judgment. Real-time application of MCDA is further restricted by system designs that are not upgraded for rapid decision-making in emergency medical situations. Additionally, the technical complexity of some tools, including ELECTRE III and hybrid models, causes challenges requiring specialized computational skills and software that may not be accessible in typical emergency care environments. Although MCDA shows very important potential as a decision-support tool for cardiovascular emergencies, several areas require additional research. Most existing studies focus on treatment selection and risk assessment, while there is limited examination of how these methods are used in emergency triage systems or in guiding resource allocation during critical situations. There is also a lack of research on the implementation of MCDA in resource-limited settings, even if some evidence shows that these areas could benefit most from such tools. Overall, studies on real-time applications of MCDA for cardiovascular emergency support remain scarce, leaving practitioners with limited practical access. Future research should aim to develop MCDA tools capable of functioning efficiently

within electronic health systems to provide timely clinical support. Models require validation and standardization to confirm their effectiveness, and other comparative studies are needed to identify which tools produce the best clinical outcomes, thereby guiding adoption and establishing uniform practice standards. Current evidence shows that MCDA serves as a very important instrument, supporting clinicians in making more informed decisions during cardiovascular emergencies. Its flexible evaluation frameworks provide structured methods for managing complex, time-sensitive decisions. However, further investigation is necessary to address gaps in geographic applicability, standardization, and immediate operational readiness. Integrating advanced MCDA frameworks into routine emergency care, with enhanced development and optimization, holds the potential to improve clinical outcomes for patients globally. (Gongora-Salazar et al., 2023)

The value of MCDA applications in cardiovascular emergencies is also explored by existing literature. For example, Thokala et al. (2016) conducted a study review on six studies from different geographic regions to study the patterns in the selection of MCDA methodologies regarding their areas of application, evaluation of criteria, and the influence of stakeholder involvement. The findings show that healthcare providers can effectively implement MCDA in short-period healthcare settings to increase the clinical decision-making process when there is a need to consider multiple and complex factors at the same time. The major applications that are identified include diagnostic support, treatment prioritization, and risk-benefit assessment. All of these applications play an important role during cardiovascular emergencies that require rapid response and involve complex ethical considerations. Across the reviewed studies, four key decision factors were highlighted: survival outcomes, clinical severity, risk-benefit trade-offs, and patient preferences. The research further demonstrates that MCDA approaches are highly adaptable, meeting the needs of local healthcare priorities, resource restrictions, and cultural values. These findings align closely with the patterns identified in the present scoping review, indicating that the main application areas of MCDA identified by the previous researchers continue to be relevant in present-day cardiovascular emergency management.

As stated by Stewart, French, & Rios (2013), in responding to cardiovascular emergencies such as cardiac arrest, stroke, and acute myocardial infarction, health providers have to make rapid decisions that may determine survival in a stressful environment with high uncertainty. Traditionally, these decisions are based on established risk scoring systems such as GRACE (Global Registry of Acute Coronary Events) and TIMI (Thrombolysis in Myocardial Infarction), supported by clinicians' professional judgment. While useful, such methods rely on a narrow range of factors and, as such, cannot fully capture the richness of clinical assessment. MCDA combines diverse qualitative and quantitative elements in one analytical framework. Factors considered in MCDA go beyond mortality rates to include patient health status, availability and accessibility of medical resources, cost of treatment, and quality of life after intervention. By offering transparent, rational, and reproducible decision-making processes, MCDA may enhance the quality of care, equity in resource distribution, and patient satisfaction.

This study points out MCDA's major advantage, which is its ability to combine a wide range of perspectives from various stakeholders involved, particularly patients, clinicians, and health system administrators. Patients can state what is important to them, including values related to dignity and autonomy, their preferences for treatment options, and expectations about quality of life after care. Clinicians give information based on their clinical experience, such as the success rates of treatments, realistic chances of survival, and practical medical strategies. Administrators are concerned with the efficient use of resources, adherence to regulations, and the health outcomes of an entire population. MCDA allows all of these groups to contribute to different choices in healthcare. This can result in shared responsibility and increased trust in decision-making processes. This shared decision-making approach reflects current healthcare priorities that emphasize on equity, transparency, patient involvement and collaborative decision-making. Research cited in the review adds points to MCDA’s use internationally. China, Taiwan, Turkey, and the Netherlands have used, along with various multinational research studies, different MCDA methods such as AHP, TOPSIS, ELECTRE III, and additive scoring systems. How a method is chosen and which evaluation criteria are used depend upon the particular healthcare objectives and obstacles of the region. To exemplify, China and Taiwan prioritize survival-related indicators. Because these countries have performance-based health service models, efforts focus on objectives like increasing one’s chances of survival. In contrast, Turkey uses clinical severity to make sure that the limited resources of its emergency care settings are used

most effectively, while the Netherlands bases decisions on the preference of the patient, the ethical orientation, and the democratic nature of Dutch policymaking. All things considered, the literature demonstrates that MCDA is flexible and universally applicable in support of decisions, but that it needs to be tailored to meet the unique values, priorities, and needs of each country's healthcare system (Gongora-Salazar et al., 2023).

Limitations and Challenges

The MCDA decision-making tool has considerable advantages but also significant challenges in operational use, which can weaken its functionality in cardiovascular emergencies. A major challenge lies in the integration of different datasets and multiple stakeholder perspectives because constructing one comprehensive model that includes all the important factors related to patient characteristics, disease severity, available resources, and treatment options is complex. The growing environment is another challenge because the diversity of data quality and availability is the other issue that increases the risk of incompleteness, out datedness, or unreliability of the inputs that later have an impact on MCDA outcomes. On top of that, MCDA is generally very sensitive to the trustworthiness of the data that is supplied into it, and the rapidity of immediate care sometimes makes it difficult to utilize the advanced MCDA tools unless it is fully integrated within real-time clinical support systems. The weighting of decision criteria might also be exposed to subjective judgments, so that it increases the risk of bias if transparency is not guaranteed. Several models require advanced statistical or computational expertise, which reduces their accessibility in urgent clinical situations. In addition to this, ethical conflicts further complicate the decisions, particularly in balancing patient autonomy, overall use, and distributive equity. For example, admitting a younger patient at the expense of an older patient to an intensive care unit may increase overall benefit but may violate principles of fairness. Due to the existence of such barriers, MCDA has rarely reached routine emergency workflows, including the lack of standardized tools, insufficient clinician training, poor interconnection with the electronic medical records, and resistance from professionals who depend more on intuitive decisions. Overcoming the obstacles requires coexisting undertakings in the areas of capacity-building, electronic integration, and dissemination of evidence on the practical added value of MCDA. Additional challenges are given because the fixed assumptions upon which many MCDA models rest may not precisely reflect the real-time conditions of the particular emergency. Moreover, the presence of different priorities between patients, clinicians,

and administrators complicates consensus on the relative importance to be afforded to decision criteria, and inappropriate weighting or aggregation may introduce bias into a decision. The decision-makers themselves are susceptible to cognitive biases, such as anchoring or confirmation bias, which can weaken objectivity. Methodologically, the technical sophistication needed to develop and analyze MCDA models constrains field applications, while the absence of a universally accepted MCDA approach to healthcare adds further inconsistency in interpretation and implementation. Trade-offs among alternative criteria need careful communication with stakeholders, while uncertainty in MCDA might be mitigated through probabilistic modeling and sensitivity analyses, these solutions require sufficient data, time, and computational resources. Practical limitations include the availability of personnel, software, and training, which also restrict MCDA use in emergencies, and the need for trained professionals makes it difficult to put into practice under straitened conditions. Only limited empirical research has assessed the real-world impact of MCDA in cardiovascular emergency care; some potential areas for development include comparisons between MCDA tools and traditional risk scores in clinical trials of triage, development and validation of computerized MCDA systems for integration within hospital databases, evaluations regarding patient satisfaction and the ethical considerations of MCDA-based decisions, and cost-effectiveness analyses comparing MCDA-guided interventions against those based on conventional approaches. Strategic recommendations for addressing such lacunae and therefore optimizing practical utilization of MCDA in cardiovascular emergencies have been developed based on the findings of this scoping review. Such initiatives include those aimed at enhancing both clinical effectiveness and ethical soundness, one main suggestion being that simple, user-friendly MCDA templates should be developed and integrated into electronic health records or mobile applications to permit timely and practical use in the emergency setting (Gongora-Salazar et al., 2023).

Building on these suggestions, complexity and usability in clinical settings remain as additional barriers. As highlighted by Stewart, French, & Rios (2013), many MCDA tools are too complex or slow for clinicians who must act quickly during cardiovascular emergencies, leaving them little time for lengthy calculations or complicated steps. To address this, MCDA should be fully digital, easy to use, and built into EHRs or available as a mobile app. These tools should pull in data automatically, like vital signs, lab results, and medical history, and use preset criteria with instant scoring. For instance, if a patient shows signs of a heart attack, the MCDA app could quickly gather key information from the record and suggest treatments based on survival chances, other health risks, and available resources. This would cut down on manual work, speed up decisions, lower the risk of mistakes, and make it easier for clinicians to accept the tool. The interface should be simple to learn and use, with clear visual cues like color-coded rankings to help clinicians make fast, informed choices. Ethical use of MCDA also means involving patients and the community when deciding what criteria matter most and how much weight to give them. Respecting patient choices and community values keeps decisions from being made only by clinicians. Bringing in patients, caregivers, and community members through advisory groups, discussions, surveys, and focus groups helps make sure the models match cultural values and real needs. Some communities might care more about quality of life than survival, while others might focus on costs. Including these views makes the system fairer, more trusted, and more likely to be accepted, and it helps avoid top-down decisions that miss real-life concerns or worsen inequalities. To create training programs that help emergency physicians and nurses better understand and use MCDA tools is another important goal. The effectiveness of MCDA depends on how comfortable and skilled the users are. Most emergency healthcare professionals have little background in decision science, so introducing MCDA without proper training could lead to mistakes or missed opportunities. To address this, standardized modules should be included in nursing and medical school courses, emergency medicine residencies, and continuing education. These modules should cover the basics of MCDA, show how it applies to real clinical cases (especially in cardiovascular emergencies), offer hands-on experience with electronic MCDA tools, and discuss ethical issues like fairness and clinical benefit. With this training, clinicians will be able to use MCDA confidently in urgent situations. Another suggestion is to improve decision support infrastructure in low-resource settings, especially in LMICs. In these areas, healthcare workers often face staff shortages, limited technology, and unreliable data, making

urgent care and resource decisions even harder. MCDA can help improve these decisions, but only if the right infrastructure is in place. This requires investment in digital systems, regular data collection, affordable software, technical support, and platform maintenance. Governments and global funders should make integrating MCDA into public health strategies a priority, as it offers a cost-effective way to improve emergency care in underserved regions. So there is a need for harmonization in how MCDA is designed and used both globally and within countries. Current research shows a wide variability in the choice of criteria, scoring approaches, and weighting strategies, which makes comparisons and scalability difficult. To ensure that MCDA consistently contributes to healthcare improvement, it is important that regulatory bodies, professional organizations, and international agencies, such as WHO and International Society for Pharmacoeconomics and Outcomes Research (ISPOR), establish unified standards. These standards would enumerate core criteria for specific emergency conditions, such as acute myocardial infarction and stroke, define validated weighting procedures, and set expectations with regard to transparency, stakeholder involvement, ethical practices, and protection from conflicts of interest.

In summary, MCDA has the potential to be a major advancement in cardiovascular emergency care, particularly in situations where clinicians must make rapid decisions under complex conditions or with limited resources. Realizing this potential requires a purposeful and structured implementation strategy. Harmonizing digital solutions, actively involving patients and communities, providing professional training for healthcare workers, improving technological infrastructure, and establishing consensus on best practices are all critical steps. When these measures are in place, MCDA tools can support decision-making in cardiovascular emergencies in a timely, accurate, ethical, and patient-centered manner.

Final Reflections

This Study has demonstrated that MCDA is a promising approach for improving clinical outcomes in the management of cardiovascular emergencies. It enhances decision-making by combining multiple stakeholder perspectives and diverse decision factors into a structured framework. MCDA also facilitates a more holistic, transparent, and justifiable decision-making process better than traditional approaches. In the dynamic and hectic nature of the healthcare environment, which is often characterized by rising patient expectations, complex cases, and limited resources, there is an urgent need to transform decision-making support. MCDA represents a valuable approach for enhancing precision, fairness, and accountability in situations where rapid, high-stakes decisions are necessary. Although MCDA is still in its early stages of study and implementation, the findings of this thesis highlight the need for continued development and refinement of MCDA techniques. If applied appropriately, supported by strong institutional structures and implemented thoughtfully, MCDA has the potential to become a key decision-support tool in cardiovascular emergency medicine. The broad adoption of MCDA could contribute to saving more lives and promoting equity in healthcare delivery on a larger, possibly global scale.

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