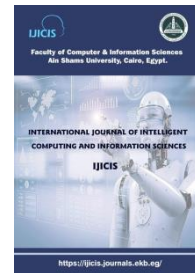




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### ADVANCES IN DECISION SUPPORT SYSTEMS' DESIGN ASPECTS: ARCHITECTURE, APPLICATIONS, AND METHODS

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**Abstract:** *When it comes to deciding on significant matters pertaining to their businesses, a large number of businesses and organizations rely on what are known as decision support systems (DSS). Both the theory and practice of decision support systems are continuing to advance, and they are occasionally converging with other significant advancements in information technology (IT), such as organizational computing, e-commerce and business, and pervasive computing. A well-designed decision support system is an interactive software-based system that assists decision-makers in identifying problems, finding solutions to those problems, and making decisions. This assistance might come in the form of raw data, documentation, personal expertise, or business models. Building decision support systems around the concept of providing the people who will use them with the tools that will assist them in analyzing data, applying models and databases, and finding viable answers to the problems they face is the primary focus of the development of these systems. Bringing attention to recent developments in decision-making assistance systems is the primary objective of this research. In addition, we discuss both the positive and bad sides of utilizing a decision support system, all of which are essential concepts to know in order to avoid repeating the same errors twice. In the very last step, but certainly not the least, we discuss the scenarios and the many forms of decision aids. This was accomplished by providing an in-depth summary of more than fifteen separate investigations.*

*Keywords:* Decision Support Systems, Survey on DSS, Decision, Decision-making Skills.

## 1. Introduction

Decision support systems (DSSs) are increasingly significant systems of information that are helpful in making decisions and are associated with semi-structured and unstructured problems with no simple solutions. These systems are presently used in a variety of fields, such as catastrophe avoidance, medical diagnosis, sustainable development, agriculture, inventory organization, sales projections, and production design. Over the past 30 years, DSSs have progressed from simple model-oriented systems into advanced multifunctional entities [1]. Most DSSs in the 1960s were based upon powerful (and expensive) mainframe computer devices that generated organized, monthly reports for managers [2]. DSSs have grown into more complicated computer-based systems that have supported promotions, production, marketing, pricing, and certain logistical operations, such as the management information system (MIS) theory developed during the 1970s [3]. Academics became more interested in decision support systems in the early 1980s, and the DSS framework was considerably broadened by the decade's end [4]. In the 1990s, a paradigm shift in DSSs emerged, accompanied by increasingly intricate systems from various domains in business operations, which combined modern database technology and client/server capabilities [5]. Object-oriented technology and data warehousing have started to impact DSSs, and many firms have upgraded their network infrastructures [6]. The rapid rise of the internet has resulted in expanded DSS reach, which has further resulted in the development of numerous novel systems, such as online analytical processing (OLAP) and other web-based systems [7].

Today, data analysis is a requirement for future corporate success in a variety of disciplines, as it has allowed for better-informed decision-making, faster problem-solving, and a higher level of efficiency when dealing with challenges, operations, event management, and planning [8].

A decision is an option pick made after considering all of the relevant factors. Making decisions is an integral aspect of issue-solving, and doing it well often requires negotiating complex challenges. This forces the decision-makers (DMs) to devise a collection of possible alternative choices that should achieve the goal, select a decision based on the benefits and drawbacks of each option, put the chosen decision into practice, and finally verify whether the intended goal has been achieved [9]. Alternatives are actions that can be taken to solve a specific problem or help attain a certain goal [10].

The quantity and quality of accessible options influence decision-making. If the number of choices is small, then a rapid and potentially dangerous decision may be made; if the number of alternatives is large, then there may be uncertainty as to whether the best selection will be made from the set of options [11].

As a result, the criteria for evaluating these alternatives must be established for selecting the finest option from among the existing options. These criteria are designed to assess the efficacy of various alternatives that are compatible with various types of system performance (i.e., the choice that meets the most stringent performance standards). These criteria might be ethical, economic, legal, procedural, or political [12].

Thus, the process of analyzing alternatives is divided into two stages: first, the examination of alternatives or choices, and second, the exclusion of alternatives or options [13].

A computerized program that is designed to help reach conclusions, rulings, and courses of action in a corporation or organization for supporting decision-making is known as a smart system. This system sifts through and analyzes large data volumes, producing detailed information that could be utilized for solving issues and making decisions. Expected or target revenue, sales numbers, or previous revenue from a

variety of time periods, legal information and circumstances, investment information, and other inventory or operations data are examples of typical information that may be processed by such a system. [14].

DSSs can be described as types of those computerized information systems, which are helpful in the decision-making process regarding the previously discussed aspects. The interactive computer-based systems and subsystems design assist the DMs in decision-making with the use of communication technologies, documents, data, models, and/or knowledge [15].

A decision support system could contain an artificial intelligence (AI) or expert system that could graphically represent information, which could be directed toward corporate leaders or other employee groups [16]. Such a system could access comparative data figures, relational and legacy data sources, projected figures that are based upon new assumptions or data, and consequences of various decisions based on past experience, which might be gathered and presented by a decision support application [17]. Decision support systems are useful because they supply data that can be incorporated into strategies. The importance of quality information over quantity is emphasized. While factors like freshness, correctness, consistency, and objectivity are important, the most crucial aspect of information quality is how it is put to use to accomplish a goal [18].

Our main objective is to illustrate the advances that contribute to decision support systems' understanding. Using a decision support system also has pros and cons aspects, which need to be understood in order to avoid repeating mistakes. As a final point, we discuss scenarios and decision aids. An overview of over fifteen studies was provided in order to achieve this.

The rest of the paper is organized as follows: in the second section the description of decision typologies is given and Comparison among the Programmed and Non-Programmed decisions. In the third section, we have presented various definitions of decision support systems as well as conditions and tiers of the decision-making, architectures, pros, and cons of a decision support system. In the fourth section, we have presented a classification of DSSs. In the fifth section, decision-making conditions are presented. The previous work in the various fields of decision support systems such as industry, investment, and medical are also presented in the sixth section. Last but not least, the conclusions and suggestions for further research are given in the "Conclusions" section.

## **2. Decision Typologies**

As outlined earlier, there are several decisions involved in the daily practices of all companies and organizations worldwide. In this study, we describe the most relevant classification types suggested by numerous researchers in the DSS area. In 1960, H. A. Simon suggested the first classification of decision structure that was based on decisions' programmability [19]. He distinguished decisions based on the extent to which they are programmable. The 2 main decision classes that are made by managers have programmed decisions and non-programmed decisions, as shown in Figure-1 [20]. This is determined based on the decision maker's responsibility, clout, and position in the company's decision-making structure.

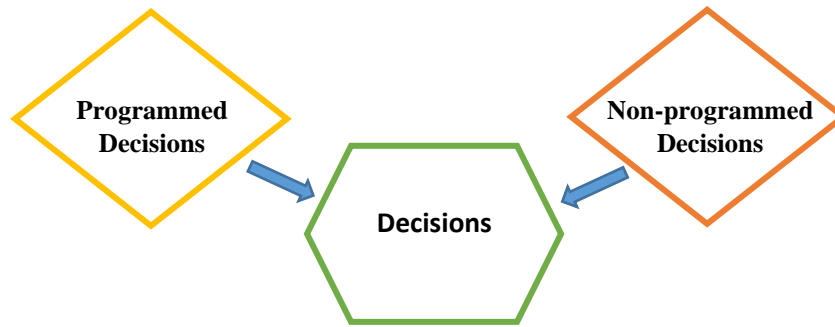


Figure 1. Decisions Typologies

- i. Programmed decisions [21] are essentially automated operations, or general regular tasks, in which decisions are made several times. These choices are made in accordance with specific principles or rules.
- ii. Non-Programmed decisions [22] would be novel decisions since they occur in uncommon and unaddressed settings.
  - There are no regulations to which to adhere.
  - These decisions depend on the manager's discretion, constitution, observation, and judgment, and they are based on the available facts.
  - Non-programmed choices are common in decision support systems.

Table-1 shows the differences between programmed and non-programmed decisions [23].

Table 1. Comparison among the Programmed and Non-Programmed Decisions

Programmed Decisions	Non-programmed Decisions
Utilized for frequent organization situations, external as well as internal.	Utilized for distinctive and ill-structured cases in an organization, external as well as internal.
Follows non-creative and structured patterns.	Takes “outside the box” unstructured, creative, and logical approaches.
Principally made by lower-level managers.	Principally made by upper-level managers.

Unlike programmed judgments, which are used to solve structured problems, non-programmed ones are employed in the case of unstructured problems [24].

Note that non-programmed judgments are made at the highest levels of an organization, whereas programmed ones are made at the lowest [25]. Each is crucial to the smooth running of a firm. In addition, they work well together to manage the organization's resources and set strategic goals [26].

### 3. Decision Support Systems (DSS)

In order to keep up with the ever-increasing need for prompt and accurate decision-making, it has become important to adopt innovative information management methods and procedures. The more traditional methods of making decisions have been rapidly impacted by recent advancements in information technology. Because of its interaction with the cloud and several other internet platforms, as well as the extensive data production tools available today, systems have gotten increasingly complicated. As a result, a decision support system, often known as a DSS, needs to be reliable. DSSs provide assistance to management in a variety of activities, ranging from the planning stages to the actual execution stages of operations across the value chain. Throughout its history, the Decision Support System (DSS) has gradually shifted its focus from that of a computer-based decision-making system to that of a system that is able to acquire, acclimate to, and arrange itself within an environment that is both uncertain and fluid [27]. The advent of personal computers, computer networks, massive database systems, and the rapid proliferation of computer-based models gave rise to a significant interest in the creation of decision support systems, which eventually led to their development. Following an examination of recent research, a number of different DSS definitions have become apparent. The term "DSS" was not initially used until the beginning of the 1970s. It is feasible to build a single definition of DSSs using numerous different definitions in order to make it more compact.

In the paper titled "Models and Managers: The Concept of Decision Calculus," the term "decision calculus" was initially defined as a "model-based set of methods for processing facts and judgments to support a manager in his decision-making." Specifically, this definition referred to the decision calculus as a "model-based set of methods for processing facts and judgments to support an Addition, it was suggested that such a system ought to be user-centric, intuitive, simple, highly adjustable, and able to react to the preferences of the individual.

In their article titled "A Framework for Management Information Systems," Gorry and Scott Morton (1989) established the term "decision support system" (DSS) and developed a 2-D model for computer support of managerial activities. They did this by using Simon's (1960) categorization of structured versus unstructured decisions and Anthony's (1965) categorization of managerial activity as tactical, operational, or strategic. Both of these categories were taken from Anthony's (1965).

James O'Brien defined a decision support system (DSS) as a computer-based information system (CBIS) that supplies information to assist business professionals and managers in making better decisions, and it has been designed expressly for the purpose of assisting and resolving unstructured management challenges [28].

According to Liker, decision support systems can be defined as computerized, interactive systems that help decision-makers by employing data and models to address and resolve unstructured and semi-structured problems in a way that takes into account managers' various preferences and approaches to the process of resolving problems. Specifically, Liker states that decision support systems help decision-makers by employing data and models to address and resolve unstructured and semi-structured problems in a way that takes into account managers' This is in line with the concept presented in (CASE MAKER),

which advocates providing managers with the tools necessary to cope with semi-structured as well as unstructured issues [29].

Some argue that decision support systems are a management information system extension, providing managers with data and tools that are needed for making decisions. Whereas information systems for management provide routine and structural information that is needed for administrative decision-making, DSSs provide managers with help in solving nonroutine and unstructured problems [30].

Informatics experts agree that DSSs can offer full support for semi-structural decision-making, the majority of which is associated with tactical (i.e., central) departments. By contrast, there is disagreement about the role of those systems in resolving nonstructural problems involving senior management (strategy) [31]. Therefore, the primary concept behind DSSs is to create systems that provide eventual benefits with tools for analyzing data, utilizing models and databases, and comparing potential solutions to the problems they face [32].

In the 20th century, many researchers in the field presented various hypotheses. As the decision process extends through time, it is natural that this process should be modeled as a sequential process of various phases. Some decision-making models have six essential tiers that managers are advised to follow while making decisions. Managers should identify and diagnose the problem, discover possible solutions, assess alternatives, pick one, execute the choice, and evaluate the decision [33], as shown in Figure 2.

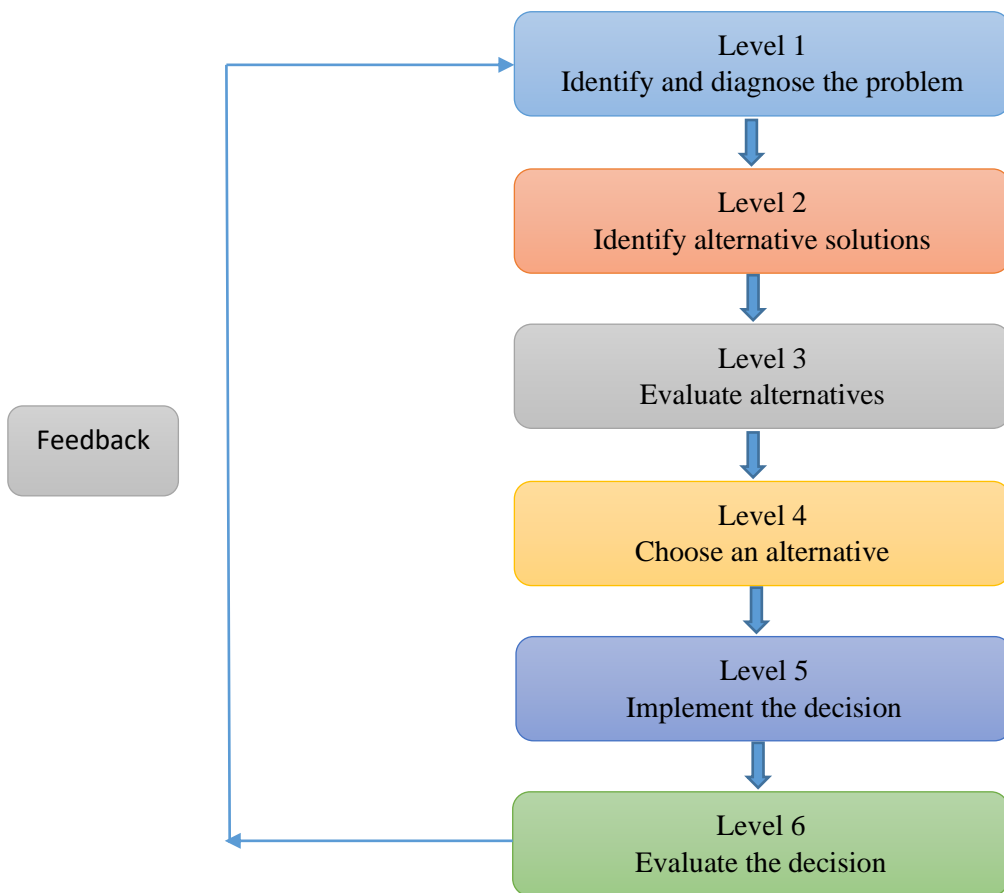


Figure 2. Tiers of the Decision-Making

### 3.1 Intelligent Decision Support Systems

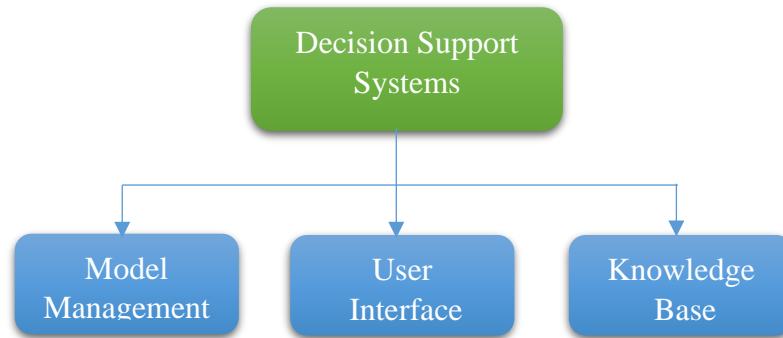
DSSs can also benefit from the use of artificial intelligence (AI) [34]. IDSSs, or intelligent decision support systems, are artificial intelligence systems that sift through mountains of data in search of insights and actionable recommendations. They achieve this by performing a data-driven analysis in an effort to simulate the human decision-making process [35].

IDSSs collect and analyze information in the same way that a human consultant would, presenting problems and possible solutions to DMs and letting them weigh the pros and disadvantages of each [36]. When it comes to processing and interpreting data, the DSS's AI component comes out on top, mimicking human abilities as precisely as possible [37].

Advanced abilities such as machine learning, knowledge base, data mining, and user interfaces could be included in IDSSs. Smart or flexible systems of manufacturing, intelligent marketing, and medical diagnostics all represent examples of IDSS applications [38].

### 3.2 Decision Support System Architectures

There are 3 basic DSS architectural components, as depicted in Figure 3:



**Figure 3.** Structure of the DSS

- i. **Model Management System:** The model management system stores the decision-making models that may be employed by managers. These models are used to make decisions concerning the financial health of the organization and project demands for a service or product [39].
- ii. **User Interface:** A DSS user interface contains features assisting end users in system navigation [40].
- iii. **Knowledge Base:** Information from internal (i.e. information that was brought together in a system of transaction process) as well as external (i.e. on-line databases and newspapers) sources are included in the knowledge base [41].

### 3.3 Benefits of Decision Support Systems:

The advantages of a decision support system, often known as a DSS, are not always as obvious as those of other types of systems. It is important to identify the benefits of a decision support system (DSS) because systems that are implemented without understanding the prospective benefits for a particular context will not achieve their full potential in contributing to the performance of an organization. This is one of the reasons why it is important to identify the benefits of a DSS. Because the use of DSS is often voluntary, it is essential that the benefits of the system be immediately obvious after it has been

implemented. Otherwise, the system will be abandoned. In addition, having a track record of delivering DSSs with benefits that are able to be identified, commented on, and quantified opens up more chances for individuals who built and implemented the systems. Additionally, it helps a business understand how to effectively prepare for and achieve future DSS success, which is another benefit. In general, the recognized benefits include improved knowledge processing, improved ability to cope with large or complex problems, reduced decision-making times, reduced decision-making costs, increased exploration or discovery, new perspectives, substantiation of decisions, increased reliability, improved communication, improved coordination, increased satisfaction, decisional empowerment, and competitive advantage. All of them, with the possible exception of the advantage of competition, indicate a way in which the decision-making process might be made more effective [42].

There are several advantages to implementing and using DSS. However, DSS also has a number of drawbacks. Table-2 below highlights some of these benefits and drawbacks [43]:

**Table 2.** Pros and Cons of a Decision Support System

Pros of DSS	Cons of DSS
The usage of a decision support system streamlines and quickens the process of making decisions. That the DSS can gather and process information in real-time is plausible.	Because the expense of developing and implementing DSS is a considerable financial outlay, it is not available to smaller business enterprises that are just starting out.
With the help of a DSS, time-consuming administrative activities can be automated, freeing up managers to focus more of their attention and energy on decision-making.	Since the information system considers every aspect of a problem, the use of a DSS could lead to information overload. The end-user faces the problem of having many different options.
A DSS encourages internal training because specific skills must be advanced to execute and manage DSS inside an organization.	Because the DSS is incorporated in daily decision-making procedures to increase speed and efficiency, a corporation could become dependent upon it. Managers tend to rely too heavily upon the system, eliminating decision-making subjectivity.
A DSS leads to increasing intraorganizational, and interpersonal communications.	Employees at lower levels may react negatively to the introduction of DSS out of fear and resentment. It's possible that many people are terrified of new technologies because they don't know how to use them and are concerned about losing their jobs.

Additional attributes of a decision support system include:

- i. Users can edit, add, delete, change, or rearrange essential parts of the DSS since it is adaptable and elastic.
- ii. The DSS should be easy to use and have a powerful graphical interface.
- iii. Rather than focusing on efficiency (the cost of decision-making), DSS aims to increase decision-making effectiveness (appropriacy and quality).
- iv. DSS tries to assist decision-makers rather than replace them. As a result, they will have complete control over the entire process.

**4. Classification of DSSs**



Different varieties of DSS are distinguished by the kind of data they are designed to process. These fall under five broad categories:

#### 4.1 Communication-driven DSS

The majority of DSS types with a focus on communication have been developed for use by internal teams, which may or may not include partners. Their purpose is to facilitate user cooperation and meeting organization. The most popular method for setting up DSSs involves deploying a web or client/server solution. Examples include web-based meeting tools, online collaboration platforms, and chat and instant messaging apps [44].

#### 4.2 Data-driven DSS

The majority of data-driven DSS varieties have been developed with the end-users (staff, upper management, and suppliers) in mind. They have been put to use in data mining, the process of mining a database or data warehouse for answers in order to achieve a predetermined purpose. This DSS could be deployed in a number of different ways, including on the mainframe, in a client-server network, or over the internet. Examples of this DSS type include computerized databases with query capabilities for validating data (which may involve adding values to existing databases) [45].

#### 4.3 Document-driven DSS

The document-driven DSS types are the most commonly utilized, and they are directed toward many different users. The aim of such DSSs is to search web pages and then locate documents based on a set of search queries or keywords. A client/server or web system is the most common technology that is deployed to constitute the DSS [46].

#### 4.4 Knowledge-driven DSS:

Knowledge-driven DSS, often known as a "knowledge base," is an umbrella phrase for several systems that are utilized by both employees and external parties (such as consumers) who interact with a corporation. Most commonly, it is used to provide recommendations to upper management or to select products and services. These systems are typically deployed through client/server architectures, the internet, or through apps running on standalone PC devices [47].

#### 4.5 Model-driven DSS

Model-driven decision support systems (DSSs) are elaborate software packages that facilitate the evaluation of alternatives and the finalization of a pick. Depending on the model's settings, it can be used for a variety of purposes, such as scheduling, decision analysis, etc., by a firm's management and employees, as well as anyone interacting with the company. Hardware/software on standalone PC devices, the internet, or client/server systems can be used to implement DSSs [48]. Table 3 demonstrates what each DSS type does and how it works [49]:

**Table 3.** Types of DSSs

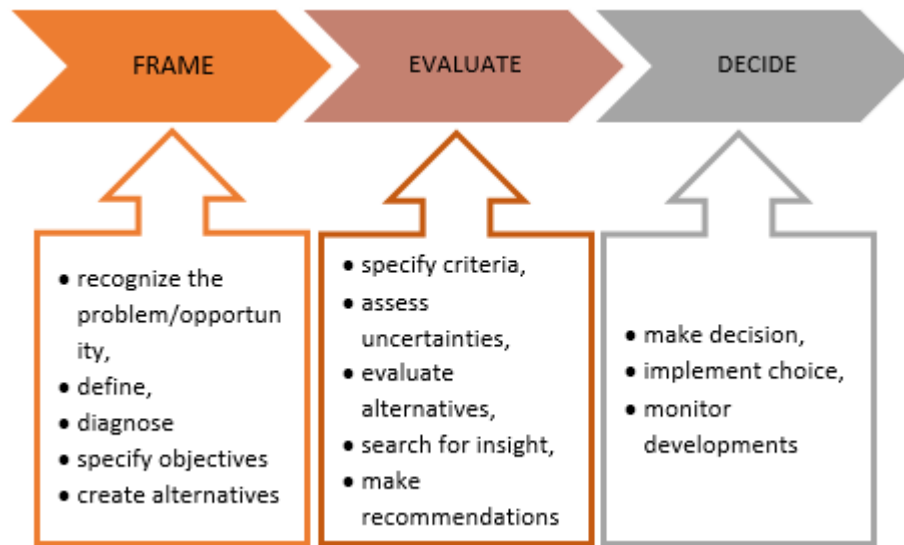
Type	What it does	How it works
Data-driven	Takes action based on information gleaned from internal or external databases.	makes use of data mining methods to identify patterns and make forecasts about the future. Used frequently to

		aid with commercial decisions involving stock levels, pricing, and more.
Model-driven	personalized in accordance with a user's specific needs as determined in advance.	Utilized in order to conduct a variety of scenario analyses in order to fulfill user needs. As an illustration, assistance may be provided with scheduling or the development of financial statements.
Communication-driven and group	Uses a variety of communication tools to permit multiple persons to be working on one task.	Enhances the level of collaboration that can be achieved between users and the system. Contributes to an increase in a system's overall efficiency and effectiveness.
Knowledge-driven	Knowledge management systems regularly update their knowledge bases with new information.	Users are given access to data that is consistent with the business processes and knowledge base of an organization.
Document-driven	Document-oriented retrieval is a subset of document-based information management systems.	Users are provided with the ability to search online pages or databases, as well as locate specific search phrases, such as those that are related to procedures and policies, company documents, and meeting minutes.

**5. Decision-Making Conditions**

There are two distinct perspectives that can be utilized while investigating decision-making: the normative view and the descriptive view. The normative viewpoint indicates what should take place, or more specifically, how an ideal decision-maker would go about completing the task at hand. The descriptive view is an account of how things really take place. One of the most significant problems with the normative process is that there is not enough time to carry out a comprehensive investigation of the various possibilities before selecting the optimal answer. Aside from that, most individuals aren't interested in the greatest alternative; instead, they are willing to settle for the first option that satisfies the minimum needs. This is a process known as "satisficing," which can imply both being satisfied and making a sacrifice [50]. The decision-making process can be broken down into different steps. Figure 4 illustrates one such phrasing that could prove to be helpful. The following are the stages that make up the decision-making process according to this formulation:

- Frame.
- Evaluate.
- Decide.



**Figure 4:** The decision-making process

In general, managers make decisions under 3 different types of conditions. The first condition implies that the available options, as well as their benefits and costs, are certain. In other words, managers are confident that specific options will result in specific outcomes, and there is no room for doubt [51].

The second condition involves risk. All available options, in addition to their possible benefits and costs, are well known in risk situations; however, the consequences are sometimes indefinite. As a result, the options are known, while the results are not [52].

The final condition regards uncertainty, in which all obtainable alternatives, their chances of occurrence, and their results are unknown. Because of the shortage of concrete information, decisions under uncertainty conditions are the most difficult to make. Such scenarios are frequently imprecise and out of the ordinary. Managers need intuition and judgment when they make decisions in uncertain situations. As demonstrated in Figure 5, the decision-making situations comprise a continuum from certainty to uncertainty [53].



**Figure 5.** Decision-Making Conditions

When managers face competing alternatives, they regularly encounter conflict, both within themselves and with other persons and organizations inside the business. In some cases, managers suffer psychological conflict when confronted with a variety of alternatives, none of which are appealing. Managers may also be presented with a variety of truly enticing alternatives, but they can be faced with

conflict since they must choose just one. Managers often face contention with other members of the company while making decisions. Unless the decision is seen as a win-win situation, there will inevitably be some level of disagreement [54].

## **6. State-of-art for DSSs**

In this part, a survey of 18 previously published works on the subject of decision support systems on business, investment, and medical topics is presented. This body of literature was divided into three sections according to the application domain of DSS. Sections 6.1, 6.2, and 6.3 respectively review the previous research regarding performance testing for decision support systems for industry, investment decision support systems, and medical decision support systems, respectively.

### **6.1 Decision Support Systems in industry:**

In [55], the authors point to a decision support system (DSS) that was developed with the intention of assisting decision-makers with multi-criteria decision-making (MCDM) difficulties such as CSP selection. Using the technology selection framework, the model for the programming language selection problem may be created [56]. In addition to this, it employs a greater number of fundamental engineering principles (such as quality standards of ISO software and MoSCoW prioritization).

According to, a novel method for manufacturing scheduling can be created by combining a predictive schedule with a proactive multicriteria decision-making strategy that is based on smart batches and their quality prediction capabilities. This combination of techniques is said to be the key to realizing the potential of this method. Within each classification was a mathematical formula that provided an estimate of the probable output quality of the following workstation. When a batch understood that its process was particularly dangerous, a collaborative decision to reschedule was initiated, and the analytic hierarchy procedure was utilized as the basis for making that decision (AHP). The article offers a summary of the suggested method, the AHP framework, and the decision problem that was taken into consideration. The AHP method was applied in a dynamic manner in situations in which smart batches that made use of the in-built NN algorithm anticipated high levels of non-quality risks, as well as those in which disturbances took place. This assertion was supported by the presentation of a simulation model that was derived from a case study of a lacquering robot. After that, the findings of a variety of different scenarios were displayed and discussed in order to bring attention to the impact that social myopia has on intelligent batches.

The authors of "58" demonstrate a methodology to assist in the decision-making process by utilizing predictive analytics. This methodology is presented as an assistance to the decision-making process. This concept was put to the test by a mining company that manages over 700 investment projects using the project management method, and that also keeps detailed and well-organized databases on the history of those projects as well as their current statuses. In addition, a large number of predictive models were examined in order to ascertain which algorithms and crucial project factors are the most helpful in providing a forecast of the likelihood of budget overruns. The authors of this piece also made use of random trees and algorithms by developing a set of guidelines that mapped the value of predictors to a certain classification of the dependent variable. They did this by developing a set of guidelines that mapped the value of predictors to a certain classification of the dependent variable. The suggested solution is constructed to provide support for decisions that were taken during significant but brief phases of a

project's lifespan. These phases include the annual budget planning and project portfolio optimizations that are carried out right before the start of the new year.

The author of reference [59] investigated the different types of legal redress that can be found in data protection statutes. Because it was motivated by the anxieties of policymakers, the General Data Protection Regulation (GDPR) provides legal measures to mitigate some of the potential adverse effects of computer-aided decision-making, according to the author. These legal measures can help mitigate some of the potential adverse effects of computer-aided decision-making. In order to provide a means of redress, it is possible that it will be necessary to extend the applicability of such instruments.

A reference paper with the number [60] has been written about locating and improving ZDM procedures. As a result of this research, we have developed a novel hybrid DSS that combines knowledge-based and data-driven methods in order to identify potential dangers and automate important decision-making procedures. As a result of this, a hybrid decision support system (DSS) has been developed to simplify the decision-making procedures involved in manufacturing activities, such as detecting and rectifying errors. Increasing productivity is one of the primary objectives of the DSS. Data-driven and knowledge-based DSSs are combined into a single type of system known as a hybrid DSS. The author draws the conclusion that the proposed DSS may boost productivity by 7.21 percent as a result of combining the benefits that can be gained from the various techniques.

It is generally accepted that making decisions through visual human-computer interaction is one of the most effective methods available in decision support systems. The findings of this study reveal a novel approach to forming judgments on the basis of visual information, which has the potential to find use in the manufacturing industry (data mining topics). When put to use for data mining, the proposed visual decision-making system ought to benefit from this in terms of its overall level of effectiveness. The decision support system is evaluated using a real-world data mining case study as the basis for the evaluation. In the end, the authors came to the conclusion that data mining was an approach for the development of DSS that was both feasible and effective. In commercial contexts, decision support systems (DSSs) that are based on data mining can be helpful for making accurate predictions and quality assessments. In conclusion, the authors demonstrated that their approach is efficient and reliable in contrast to other possible courses of action [61].

The peculiarities of the wafer fabrication process inspired the authors of [62] to discuss integrated planning and the difficulty of order acceptance for multistage, multiproduct production systems. As a consequence of this, they proposed a planning model for the acceptance of orders inside multi-stage, multi-product manufacturing systems with load-dependent lead times. Systems for the manufacture of semiconductors at the wafer level fall into this category (wafer fabs). The resulting planning formulation made use of nonlinear CFs to describe lead times that were depending on the amount of work being done. In order to address this concern, a metaheuristic that is based on VNS was developed, and the LP solution was required at each stage of the VNS method. The authors found that the proposed metaheuristic performed better than existing time-based decomposition approaches in the literature when they ran it through their computer testing.

## **6.2 Decision Support Systems in investment:**

In the paper referenced above (63), the authors suggest a utility-based hybrid fuzzy axiomatic design (FAD) approach with an ordinal aggregation strategy. FAD is an appealing multiple-criteria analysis method due to its distinctiveness in assessing the functional requirements of each criterion. This aim was accomplished by establishing methods for determining the probability of functional criterion fulfillment for five widely used evaluation expressions. Using these methods, the goal was successfully completed. The majority of MCDM methods, on the other hand, overlook the functional need, while the FAD approach takes it into consideration in order to minimize the risks associated with choosing. In addition, multiple criteria decision-making, often known as MCDM, is a method that seeks to choose the best response or construct a rating set by basing its conclusions on how well each alternative performs according to a set of criteria. This problem has repercussions for the disciplines of engineering and production, as well as management and economics. The FAD method, on the other hand, has a few limitations in terms of how it can be used. These limitations include the following three scenarios: (1) when deciding on the best possible option, (2) when dealing with only one kind of assessment representation, and (3) when making decisions as an individual. This research established a novel approach to MEMCDM known as the Ulti-HFAD-ORESTE strategy. Its purpose is to keep the positive aspects of FAD while minimizing its negative aspects by using utility theory and the ORESTE method.

According to [64], having an accurate description of information technology (IT) and an effective management strategy for the organization as a whole are both essential components of having an enterprise architecture (EA). It is crucial for today's firms to invest in the creation of EA models that provide an accurate representation of the actions and resources of an organization. There are a number of problems associated with manual modeling that have led to the development of automatic EA modeling systems. These downsides include error-proneness, slow and poor preadaptation, time consumption, and expenses. On the other hand, automatic modeling falls flat on its face when it comes to dealing with the components of enterprise architecture that are the most conceptually complicated, such as strategies and motives. As a result, businesses are expressing a desire for hybrid methods that use both computational and human-based modeling.

In the study cited as [65], 142 participants were surveyed using a quantitative research methodology to compile their results. Information was compared across businesses in the top and worst quartiles to determine differences in enterprise architecture maturity, EA artifact utilization, and the information delivered by the enterprise architecture to businesses as they plan their IT investments. Researchers found that companies performing in the top quartile exhibited greater levels of development across the board for enterprise architecture. They also made broader use of diagnostic and actionable EA artifacts in particular when planning IT investment decisions. Last but not least, the enterprise architecture added critical information for the top 25% of companies to use in making strategic IT investment decisions.

For DSS systems that combine human and machine intelligence, the authors of [66] propose certain guidelines for their design. Using a design science research method, the complementing capacities of humans and computers, and support systems for very uncertain decision-making scenarios, the authors developed a prototype artifact and a set of design principles for HI-DSS. Decision support for the validation of the models through the augmentation of the formal data analysis utilizing the iterative social interactions with the stakeholders is provided by this reference, which may be utilized to construct a similar DSS in the early-stage startup environment.

The authors of [67] advocated for a closer examination of the factors that influence a company's decision-making procedures. The writers used a combination of literature reviews, deductive and inductive reasoning, and a total of 29 in-depth interviews to reach their conclusions (IDI). Twenty-three local organizations with managers at varying levels have implemented this strategy. The interviews were designed and executed to mimic real-life conversations. On average, an interview would take about an hour. Social, economic, organizational, psychological, and individual factors have all had a role in shaping business decision-making over time. By a wide margin, respondents ranked the significance of organizational and economic considerations as their highest. Enterprise resource planning (ERP) systems, spreadsheets, customer relationship management (CRM), databases, data visualization software, and other internal software for organizational management have all been implemented with the goal of simplifying and accelerating the decision-making process and lowering barriers.

In [68], the authors present a framework for enhancing the investment decision-making procedure. The purpose of that model is to improve the decision-making process required to realize investment goals by using a multicriteria analysis approach to assess the efficiency of investments. The authors draw the conclusion that ranking investment alternatives are used to make better investment choices. The use of multicriteria analysis methods allows for alternatives to the ranking investment.

### **6.3 Decision Support Systems in medical:**

This review looked at scientific studies that have addressed the challenges with advanced signal processing and Artificial Intelligence (AI) methods as HRV signals suffer from several problems such as it being nonstationary and nonlinear and, to the human eye, they appear to be noise-like. In [69] review, looked at scientific studies that have addressed the challenges with advanced signal processing and AI methods as HRV signals suffer from several problems. Because of this, conducting an analysis on them is challenging, and even explaining the results of an investigation can be challenging. In addition, it is challenging to differentiate between the effects of the many various complex physiological processes that have an effect on the HRV. The impacts of aging and the presence of comorbidities make these challenges far more difficult to manage.

The medical service network was reorganized using a mixed integer linear programming model, which was developed as part of the study [70]. In order to make an accurate estimation of the number of patients in each time period, a fuzzy method was used. The result that was produced from the model shows that there was a 60% drop in the number of visitors to these centers. This comes on top of the fact that the shortage of hospital beds was prevented.

A decision support system (DSS) for detecting and controlling myocardial infarction (MI) as well as continuously monitoring the patient's blood pressure is presented in [71]. The DSS is based on neural networks and statistical process control charts. In order to accomplish this goal, data were gathered from 175 medical documents pertaining to patients diagnosed with MI, and 92 successful diagnoses of MI type were documented. The findings showed that utilizing a guiding flowchart and a graphical rule table in accordance with the WHO diagnostic policy provides a methodical and comprehensive picture of the infarction diagnosis. During the process of developing the rule table, we were able to attain the best possible overall accuracy of 81.25% at two different confidence levels:  $L=2$  and  $L=3$ . During the control determination, stage of CBPM, the highest and lowest overall accuracies obtained were 98.75% and 95%,

respectively. During the condition determination stage, the highest and lowest overall accuracies were 83.75% and 70%.

A unique rule-based approach was presented in the publication [72] to provide intelligent diagnostic decision-support predicated on picture PFS. These pictures of PFS are a direct generalization of classic FST and the idea of IFS. The strategy that is outlined in this paper makes use of the benefits of fuzzy logic and expands FST by employing PFS with linguistic and semantic information. This is accomplished through the development of picture fuzzy logic and implication operators in PFS, as well as the generalization of compositional rules of inference that are well-known and understood. The findings of the experiments shed light on the advantages that the strategy under consideration offers. The findings of a comparison analysis have shown that this strategy is superior to the other possible approaches that were taken into consideration.



Table 4. Literature review

Ref.	Year	Author's name	Domain	Methods	Result
[55] [56]	2018, 2021	Siamak Farshidi and et.al	Software Production	The process of selecting a programming language is treated as a multi-criteria decision-making issue, which involves analyzing a number of different options while taking into consideration a number of different choice criteria.	<ul style="list-style-type: none"> <li>▪ Based on the technology selection framework, a decision model was presented for the programming language selection problem. The innovative nature of the method contributes knowledge about programming languages to decision-makers who are not well-informed, while also contributing to the development of a robust decision model for those decision-makers who are well-informed. In addition to this, it develops the decision model by including deeply embedded requirements engineering concepts and knowledge engineering theories. These theories and concepts include things like the ISO software quality standards and the MoSCoW prioritizing technique.</li> <li>▪ The decision model's utility and effectiveness in addressing the choice problem were evaluated through the use of seven industry case studies that were conducted. It was discovered that, despite the fact that enterprises are often bound to particular ecosystems for extraneous reasons, they stand to gain a great deal from making use of the DSS. The case studies demonstrate that the decision model presented in this article also offers a framework for further work to be done on MCDM issues.</li> </ul>
[57]	2021	Emmanuel ZIMMERMANN and et.al	manufacture companies	The analytic hierarchy process (AHP) method	<ul style="list-style-type: none"> <li>▪ Using a hybrid manufacturing control system that is based on a predictive schedule and the AHP multicriteria decision method as a decision support tool in the setting of an organization that has a high rework rate was proved to be of interest in this body of work. It has been demonstrated that taking into account the number of batches (also known as social myopia) that contribute to the choice is significant, as it has a significant bearing on both the quality and the amount of time required for the computation.</li> </ul>
[58]	2021	W.Maciej and Ch.O.Iwona	Manufacture	Artificial neural network (ANN), Decision Trees, Logistic Regression (LR), Support-vector machine (SVM), Bayesian Networks Algorithms, Nearest Neighbor Analysis	<ul style="list-style-type: none"> <li>▪ According to the computed lift value, the findings showed that the 10 most effective models are those that are built on random trees. This was found by the research (all 10 cases). When taken together, these examples have a lift value that is equivalent to 1,630.</li> <li>▪ Random Trees are the building blocks upon which all ten of the most successful models are constructed, and their accuracy ranges from 80.91 percent to 81.36 percent across the board. This is in line with the correctness of the assessment as a whole.</li> </ul>

					<ul style="list-style-type: none"> <li>▪ Taking into account the area under the curve (AUC), the ten best models are those that are based on Bayes networks (6 cases), random trees (1 case), and the KNN algorithm (3 cases), with AUC values ranging from 0.869 to 0.88.</li> <li>▪ Predictor relevance is automatically determined as the reduction in variance of the goal attributable to each predictor, using sensitivity analysis, in the case of models that are based on Random Trees and the LSVM algorithm.</li> <li>▪ According to the dominant Random trees algorithm, the expenditures level, as well as the weight average month index of expenditure, have the greatest influence on the prediction, closely followed by the project's label, which is associated with the nature of the products that are being produced by the projects.</li> <li>▪ The authors were able to develop accurate predictive models by using the data from the projects, so supporting the premise that the utilization of this method can support strategic decisions made by portfolio managers by identifying projects at risk of major deviation in budget execution.</li> </ul>
[59]	2021	T.L.Aurelia	Machine	In this paper, we discuss the many redress mechanisms that are available under data protection law.	<ul style="list-style-type: none"> <li>▪ The data protection law, which combines a focus on an individual's rights with a commitment to following due processes and relies on additional statutes, has garnered a significant amount of attention in recent years.</li> <li>▪ The General Data Protection Regulation (GDPR) gives legal measures to address some of the side-effects that have been brought to light as a result of policymakers' worries over the decision-making capacities of machines.</li> <li>▪ In order to provide a mechanism for redress, the application of those tools may at times require that their reach be expanded. Depending on the scope of the expansion, there may be conflicts with the rule of law norm, which could result in unwelcome legal uncertainty.</li> <li>▪ It is important that, as the use of automated decision-making systems becomes more widespread, careful attention be paid to the ways in which these systems adapt to the specifics of each situation and the impact they have as a result. This will enable policymakers to receive additional direction regarding how to avoid or reduce the adverse effects of these systems.</li> </ul>
[60]	2021	P.Foivos and K.Dimitris	Manufacture	<ul style="list-style-type: none"> <li>• The tactics of detection and repair that are based on Zero Defect Manufacturing (ZDM) are the primary subject of this study. In addition to this, it makes use of a recently created hybrid decision</li> </ul>	<ul style="list-style-type: none"> <li>▪ Both the simulations and the actual world implementation demonstrate that the suggested DSS system is able to effectively discover flaws and automate the decision-making procedure that takes place after the flaws have been found. This study demonstrates, through the utilization of a multi-criteria approach, that the DSS is capable of handling the dynamic nature of a production system, making</li> </ul>

				<p>support system (DSS), which employs both knowledge-based and data-driven techniques for the detection of flaws, and as a result, it automates the necessary decision-making procedures.</p> <ul style="list-style-type: none"> <li>• In order to describe the production domain and augment the data that is already there with contextual information, the system makes use of an ontology that is based on the MASON ontology. The dynamic multicriteria method is being utilized in order to conduct an evaluation of the potential repair schemes.</li> </ul>	<p>decisions that are well-adapted, and assisting manufacturers in getting closer to Zero Defect Manufacturing.</p>
[61]	2020	Y. Yun and D. Ma	Industrial applications	<ul style="list-style-type: none"> <li>• Utility function, Utility curve construction, Preference visualization.</li> <li>• For evaluation used decision tree, Bayes network, concept lattice, association rules, and clustering</li> </ul>	<ul style="list-style-type: none"> <li>▪ During the course of this research, a visual decision-making system was developed. The data mining methodology was utilized to provide assistance to the system, and the architecture of a decision support system was assessed based on the findings of the data mining methodology. In addition, the results of a thorough experiment have demonstrated that the strategy that we have proposed is effective.</li> <li>▪ According to the findings of the research, the clustering approach is able to attain the highest level of performance when the probability value <math>p</math> is set to 0.6. When equals 0.5, the concept lattice approach reaches its maximum potential for performance.</li> </ul>
[62]	2021	K.W.Hung, M.Lars	Manufacturing systems	<p>Nonlinear clearing function (CF), variable neighborhood Search (VNS) based metaheuristic</p>	<ul style="list-style-type: none"> <li>▪ The findings indicate the following: The total amount of time spent computing, on average, is 615 seconds. The TBRF (4,3) scheme is outperformed by around 5.35% compared to the TVNS scheme. It is important to keep in mind that the two algorithms require the same amount of processing time for each instance. It would appear that the overload factor has an effect on the quality of the solution because the PE value is approximately 3.9% when <math>\phi = 1.1</math> is used, however it is 4.5% when <math>\phi = 1.25</math> and <math>\phi = 1.50</math> are used. This suggests that the overload factor has a role in determining the quality of the solution. A lower minimum order quantity results in an increased number of orders as well as an increased number of binary decision variables; as a result, the processing time is marginally lengthened. A</li> </ul>

					<p>longer delivery date window also results in a longer amount of time spent computing.</p> <ul style="list-style-type: none"> <li>▪ The efficiency of the TVNS scheme can benefit from an increase in the amount of time spent computing. However, we see that even for a very small computing time per instance, the TVNS scheme is able to outperform the TBRF scheme, which requires a significantly longer amount of computing time on average. This is because even a computing time per instance of only one-minute results in an improvement of almost three percent for the TVNS. An improvement of about 5% is achieved by increasing the amount of computation time for each instance by ten minutes.</li> <li>▪ In general, one can get the conclusion that the TVNS scheme is a quick method that results in high-quality answers.</li> </ul>
[63]	2020	Xingli Wu and et.al	The credit risk assessment of enterprises	Ulti-HFAD ORESTE	<ul style="list-style-type: none"> <li>▪ Methods for determining the probability of alternatives in terms of meeting the functional requirements of criteria were established, and then the outcomes of those methods were normalized in order to unify hybrid information. These methods were applied to various representation models.</li> <li>▪ Presented an alternate approach for rating things that take into account both the probabilities of meeting the functional requirements and the comprehensive values. When functional needs are measured in terms of their probability of being met, it is possible to differentiate between the positive and negative aspects of various alternatives based on each criterion.</li> <li>▪ In addition to the FAD approach, an attribute value aggregation method has been developed. This method can extract the overall value of all of the options, and it was developed as a supplement to the FAD method. According to the findings of the comparative analysis based on the case study, the aggregation approach has the potential to make the FAD method more effective in producing accurate results.</li> <li>▪ Presented an ordinal aggregation method as a means of dealing with the issue at hand, which requires the participation of a number of specialists who use varying criteria for evaluation. In contrast to the cardinal aggregation method, the ordinal form has the potential to prevent the distortion of individualized evaluations.</li> <li>▪ In conclusion, the benefits of the Ulti-HFAD-ORESTE method were highlighted in terms of visualization, stability, information type, and reliability by comparing it to five well-known MCDM methods, including TOPSIS, VIKOR, MULTIMOORA, PROMETHEE, and ELECTRE. Specifically, the results showed that the Ulti-HFAD-ORESTE method excelled in all of these areas.</li> </ul>

[64]	2020	Ricardo Pérez-Castillo and et.al	Enterprise Architecture Modeling	Genetic Algorithm	<ul style="list-style-type: none"> <li>▪ It provides a catalog of mining techniques and input artifacts that may be employed, as well as ArchiMate elements that can be discovered and modeled from them. This catalog is stored in a relational database.</li> <li>▪ It offers a similar library (what/who) regarding the ArchiMate elements that individual experts are able to model.</li> <li>▪ The decision-support system that has been presented provides assistance to EA architects so that they may make judgments that are more informed. On the one hand, it might be possible to cut back on the number of experts needed to manually model and so save money on the additional expenses caused by having too many assignments.</li> </ul>
[65]	2019	Martin van den Berg and et.al	Enterprises	EA approach	<ul style="list-style-type: none"> <li>▪ According to the findings of the study, companies who have the highest quality results as a result of their IT investment decisions are the top quartile businesses, and these companies employ EA in a different way compared to companies that have the lowest quality outcomes (bottom quartile organizations).</li> <li>▪ Businesses in the top quartile make greater use of enterprise architecture artifacts, such as heat maps, policies, roadmaps, business capability models, and landscape diagrams, when it comes to the preparation of IT investment decisions.</li> <li>▪ In these companies, enterprise architecture artifacts are not restricted to those artifacts that just provide insight and supervision; rather, enterprise architecture artifacts have progressed to become more agnostic and actionable. In addition, the EA function provides more strategic insights during the preparation of IT investment decisions in organizations that are in the top quartile. These insights focus on whether or not IT investments are compatible with the business strategy, the relationship with future and past investments, and the risks associated with IT investments.</li> <li>▪ Taking the appropriate enterprise architecture (EA) approach can help businesses improve the return on their information technology (IT) investments.</li> <li>▪ This study finally reveals that there is a favorable association between the quality of the consequences of IT investments and the amount of money invested in enterprise architecture (EA).</li> </ul>
[66]	2018	Dominik Dellermann and et.al	Business	Design science research (DSR), Hybrid Intelligence DSS (HI-DSS)	<ul style="list-style-type: none"> <li>▪ The findings of this paper demonstrate prescriptive knowledge regarding form and function, in addition to execution principles.</li> <li>▪ The findings point to the possibility of using collective intelligence in decision-making situations when there is uncertainty.</li> </ul>

					<ul style="list-style-type: none"> <li>▪ Presented an innovative method to support human decision-making by merging the intelligence of machines with the intelligence of groups of people to create a hybrid intelligence system. The findings indicate that this method of decisional guidance is particularly useful in circumstances characterized by high levels of unpredictability, which are the kinds of circumstances in which synergy between formal analysis achieved via machine learning strategies and human intuition attained via collective intelligence yields the best results. As a result, our study makes a contribution to the recent body of work on combined applications in a variety of fields.</li> <li>▪ The proposed prototype artifact offers an actual solution for helping service providers such as business incubators and accelerators to extend their service offerings beyond solely offline mentoring to a digital solution. As a result, it provides a first step toward a practical solution within the context of this problem.</li> </ul>
[67]	2021	K.N.Katarzyna and B.Karolina	In organizations	Inductive-deductive reasoning, in-depth interview (IDI).	<ul style="list-style-type: none"> <li>▪ When it came to the process of making a decision, the respondents said that economic and organizational considerations were the most significant elements to take into account.</li> <li>▪ The managers have determined that the most important economic aspects that influence the decision-making process are the business purpose, the economic account, and the resources possessed by the company. The most significant factors that determine how effectively decisions are made are the leadership style and the organizational structure.</li> <li>▪ When it came to making decisions, the most prevalent challenges that managers faced were uncertainty brought on by a lack of knowledge and data, time, and the availability of resources and financing.</li> <li>▪ Managers, more than anyone else, consider information obstacles associated with a paucity of information, financial barriers, and time pressure to be the most influential hurdles in the process of decision-making.</li> <li>▪ The process of making decisions is streamlined and has fewer hurdles thanks to the usage of a variety of IT solutions.</li> <li>▪ According to the respondents, there is a need to implement or improve an information management system in many different entities. This has the potential to have a significant impact on the decision-making process, which is especially important when considering the fact that a lack of information is the most significant obstacle in the decision-making process.</li> </ul>

[68]	2018	P.Adis, B.Admir and S.Sead	Investments	Multicriteria analysis method.	<ul style="list-style-type: none"> <li>▪ The produced model demonstrated how to make decisions on investments in a way that is both effective and efficient. Within the context of this model, the synthesis method for determining the efficiency of investment projects through the application of multi-criteria analysis procedures was carried out.</li> <li>▪ This model represents a novel strategy for dealing with the issue of making an investment decision because it combines multiple strategies into a single framework. However, this raises the challenge of selecting an investment project that, in comparison to other investment projects, yields the best results. In order to make decisions about investments, the notion of rating different investment options has been put into practice throughout this article. It is the rating of different investment options that can be accomplished through the utilization of multi-criteria analysis techniques. After calculating the value of each method, the characteristics of multi-criteria analysis methods and their application make it feasible to systematize the methods and build a rank of investment choices. This is made possible after the value of each method has been calculated.</li> </ul>
[69]	2022	Oliver Fausta and et. al.	Medical	Heart Rate Variability (HRV)	<ul style="list-style-type: none"> <li>▪ The results of this study demonstrate that HRV analysis maintains its popularity among researchers and, moreover, continues to captivate them. However, as the research continues, new barriers to comprehension appear, and crossing those barriers requires a greater depth of understanding. The advancement of technology and the accumulation of new information are inextricably linked to one another. According to our most recent understanding, advances in HRV-based healthcare technologies will be brought about by the combination of big data and AI algorithms. This usefulness is due, in part, to the intelligibility of the signals as well as the relatively low data rate but relatively high information rate.</li> </ul>
[70]	2022	Sajjad Ahadian and et. al.	Medical	Medical Service Network (MSN)	<p>The following are the primary choices that need to be taken when using this model:</p> <ul style="list-style-type: none"> <li>▪ 1- The placement and distribution of ACF centers in order to facilitate triage, outpatient care, and screening. 2- Making plans to meet future medical requirements by expanding the number of beds available in a variety of hospital wards and determining the best way to distribute off-duty medical professionals and volunteers across medical facilities. The results of the model indicate that if the model is put into action, there will be a large rise in both the number of direct referrals to hospitals and the level of care given by the network. This, in turn, will result in losses being reduced to a minimum.</li> </ul>
[71]	2022	Sheida Jabbedari Khiabani and et. al.	Medical	Neural Networks (NN)	<ul style="list-style-type: none"> <li>▪ The findings demonstrate that the proposed hybrid model is capable of diagnosing MI with a level of accuracy and precision that is superior to that of machine</li> </ul>

					learning algorithms. Higher overall accuracy was achieved by setting tighter control limits in the control determination stage with a confidence level of L=2 (corresponding to a confidence interval of 95.45%) and setting wider control limits in the condition determination stage with a confidence level of L3 (corresponding to a confidence interval of 99.73%) respectively. The use of this strategy can assist medical professionals in arriving at more accurate diagnoses of cardiovascular disorders.
[72]	2022	HaiVan Pham and et. al.	Medical	Rule-based approach	<ul style="list-style-type: none"> <li>▪ In terms of clinical diagnostic accuracy, the published findings for the suggested method reveal a high degree of accuracy, with claimed accuracy in the range of [92% to 95%] and a high confidence level when compared to alternative diagnostic matching methods.</li> </ul>



By presenting the aforementioned research, we have come to the conclusion that there is no one algorithm that can be implemented in decision-making systems that will solve all problems; rather, each problem has its own algorithm and solution that is dependent on the factors that have an impact on it as well as the objective for which the decision support system was developed. To put it in the most simplistic terms, the purpose of decision support is to help people make better judgments. On the other hand, this does not account for all of the potential advantages of a DSS. It is possible for a superior process to present itself in a variety of different ways. A more efficient procedure could lead to the same decision, but it could do so much more quickly and at a far lower cost. If the procedure were improved, perhaps more comprehension and insight might result. It's possible that a better procedure will result in the same choice, but that decision will yield benefits when it's put into action. Therefore, before creating any kind of decision support system, regardless of the system's kind, it is vitally important to define the aim that is intended to be accomplished with this system.

## **7. Conclusion**

Since the 1990s, advancements in artificial intelligence (AI), database technologies, and computer network technologies have provided tremendous technological support for the development of DSS.

In this article, we describe the findings of a study that covered 73 publications and had the objective of attaining a deeper comprehension of the recent developments in decision support systems, including the domains of application, benefits, and drawbacks associated with decision support systems. We have taken notes and provided an introduction that is more generic on DSS. In the second section, we compared programmed decisions to non-programmed decisions and discussed the many types of decisions. In the third segment, we discussed the many different definitions of decision-support systems, as well as the circumstances and levels of decision-making, architectures, as well as the pros and cons of decision-support systems. The classification of DSSs is what we covered in the fourth section of this article. Last but not least, we discussed earlier work that we had done in a variety of disciplines pertaining to decision support systems, including the medical field, industry, and investing.

To provide helpful guiding concepts for practitioners in integrated processes of implementation, design, and evaluation, as well as to determine the aspects that impact the DSS from investment, legal, and financial perspectives, it is very important for future DSS researchers to redirect their attention toward underdeveloped subspecialties. This is because it is very important for the future of DSS research. We have high hopes that this evaluation will not only provide helpful direction but also contribute to the facilitation of important research in DSS.

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