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Exploring Interactive Decision Support Systems (IDSS) for Forecasting: A Literature Review

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***Abstract*— This article provides a comprehensive literature review on interactive systems for forecasting. The concept of interactive systems, including the interactive relationship between humans and machines, as well as machine-to-machine interaction, is discussed. The definition and characteristics of decision support systems (DSS) are explored, with a focus on interactive decision support systems (IDSS). The components and architecture of an IDSS are described, highlighting the role of database management systems, model repositories, knowledge engines, user interfaces, and users. The article also examines the application of IDSS in forecasting and planning, particularly in educational systems. Different types of forecasting systems in the educational domain are discussed, including performance prediction, enrollment forecasting, and financial forecasting systems. Commercially available IDSS and their limitations are highlighted.**

Keywords— interactive decision support systems (IDSS); forecasting; educational systems;

I. INTRODUCTION

Interactive Decision Support Systems (IDSS) play a crucial role in aiding decision-makers to make informed and effective decisions in various domains. With the increasing complexity and uncertainty of decision-making processes, IDSS have gained significant attention as valuable tools for forecasting and decision support. In this article, we present a comprehensive literature review on exploring IDSS for forecasting.

The objective of this review is to analyze and synthesize existing research studies that focus on the development, application, and evaluation of IDSS in the context of forecasting. By examining the literature, we aim to identify the key trends, methodologies, and advancements in the field, and to provide insights into the potential benefits and challenges associated with the utilization of IDSS for forecasting purposes.

By conducting this comprehensive literature review, we aim to provide researchers, practitioners, and decision-makers with a valuable resource that consolidates the current state of knowledge on IDSS for forecasting. This review serves as a foundation for future research efforts and facilitates the advancement and adoption of IDSS in decision-making processes across various industries and domains.

The remainder of this paper is structured as follows: The second section present definitions related to interactive decision support systems (IDSS) and their components. The following section focuses into the application of IDSS in forecasting and planning, highlighting their significance within the broader IDSS framework. Lastly, we conclude by summarizing the key points discussed and presenting prospects for future research in the final section.

II. INTERACTIVE DECISION SUPPORT SYSTEM (IDSS)

1. Definitions

- System :

According to the Oxford English Dictionary, a "system" is described as "a set of connected things or parts forming a complex whole, in particular." In our context, it can be interpreted as a collection of programs that interact with each other to solve a problem or provide an answer.

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- Interactive :

Most researchers limit the concept of "interactive" to the human-machine interactive relationship, which is understandable in the past, where the term "interactive" was coined to differentiate from "punched-card input" or "batch processing". However, with the revolution in computing power and the development of intelligent programs capable of simulating human intelligence, interaction is no longer limited to just the human-machine interface. We will also discuss the interactive system of Machine/Machine.

- Decision Support :

According to Roy and Bouyssou [1], decision support is "the activity of providing elements of response to questions posed by an actor in a decision process, based on clearly articulated but not necessarily fully formalized models. These elements contribute to illuminating the decision and normally recommend, or simply favor, a behavior that enhances coherence between the evolution of the process, on the one hand, and the objectives and value system to which these actors are committed, on the other hand."

The decision-making process is not solely dependent on human expertise, as this task can be performed by machines or autonomous systems.

- Decision Support System

A decision support system (DSS) is a computer-based system that enables a company or organization to make better decisions. Decision support systems serve the management, operations, and planning functions within an organization and allow users to make decisions on rapidly changing and ill-defined problems. DSSs can be fully automated, human-driven, or a combination of both.

- Interactive Decision Support System

The Interactive Decision Support System (IDSS) plays a significant role within the information system. It serves as a culmination point for the IS.

Interactive Decision Support Systems (IDSS) can be classified into three categories[2], distinguished by the time scale and scope of the decision-making process. The first category is Operational IDSS, which helps operators quickly deal with complex situations by offering them solutions that alleviate constraints (for example, an IDSS for an airline's operations team that provides alternative flight and crew arrangements in case of incidents). The second category is Management IDSS, which enables operational managers to access daily indicators and useful alerts for overseeing the work of operators (e.g., monitoring quality standards and resource utilization). The final category is Strategic IDSS, which presents monthly time series to executives, providing insights into the efficiency and positioning of the organization. It allows the executive committee to have an early and shared evaluation of key performance indicators.

2. *Constitution of IDSS*

According to Marakas [3], the components of an IDSS (See Figure 1) can generally be classified into five distinct parts:

a. A database management system and the associated database: which stores, organizes, sorts, and retrieves relevant data for a specific decision context.
b. A model management system and the associated model base: which has a similar role to the database management system, except that it organizes, sorts, and stores the quantitative models of the organization.
c. The knowledge engine: which performs tasks related to problem recognition and generation of final or intermediate solutions, as well as functions related to problem-solving process management.
d. A user interface: which is a key element in the overall system's functionality.
e. A user: who is an integral part of the problem-solving process.

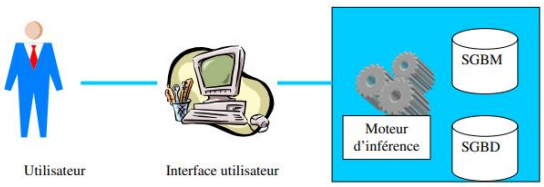

Figure 1 : Architecture of IDSS according to [3]

According to Sprague and all [4], IDSS are composed of three essential parts:

- Database
- Model base
- Set of complex software that ensures the connections between the user and each of these bases.

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III. IDSS FOR FORECASTING AND PLANNING

IDSS focused on planning, as described in [5], is a model that aims to plan and prevent the production of a supply chain based on unstable demand. They chose a model in which decision parameters are related to the production management process. Krishnaiyer [6] propose the design of an IDSS that considers machine planning and inventory management in a diverse product manufacturing industry. Algorithms are also proposed in [7] to define a production planning model that takes into account various constraints. To ensure a high level of customer service, the optimal solution is obtained only after gathering and analyzing information from different systems. One of the advantages of these IDSS systems lies in the choice of web applications, which provide a reliable advanced technology for modeling a range of services. The IDSS for paper production planning by IBM (A-Team), presented in [8], consists of three types of agents that work asynchronously: "builders," "improvers," and "destroyers."

The "builders" agent is responsible for defining the problem and creating new solutions.

The "improvers" agent enhances the set of solutions by modifying and combining existing solutions.

The "destroyer" agent handles the removal of poor solutions and guides the efforts of the "improvers" to limit the number of solutions.

For forecasting, a reliable IDSS must meet a set of additional criteria. Beyond the interactive and user-friendly nature of the interfaces and the simplicity of the processes, an IDSS for forecasting and planning should have access to a significant historical data set, enabling it to rely on stronger training. In general, IDSS for forecasting in the educational system can be classified into three categories:

- School Performance Forecasting Systems: These systems utilize machine learning techniques to predict students' academic performance using historical data on their performance, socio-economic background, and engagement in school.
- Enrollment Forecasting Systems: These systems employ time series techniques to predict future student enrollments in schools and school districts, using historical data on enrollments and withdrawals.
- Financial Forecasting Systems: These systems use statistical modeling techniques to forecast the future finances of schools and school districts, using historical data on expenditures and revenues.

Several IDSS systems are commercially available, including ForecastPro (ForecastPro, n.d.) and PowerSchool (PowerSchool, n.d.). These two software solutions utilize forecasting models based on statistical and machine learning approaches. However, they employ simple models and do not allow for the use of hybrid models.

In general, we have observed a lack of IDSS systems for forecasting in Morocco. We have not found any IDSS that specifically cater to forecasting, which is a crucial step for anticipating resource demands in educational institutions, whether at the university or school level.

According to Rob [9], the forecasting process consists of multiple stages, and the success of the task depends on the completion of each stage. Figure 2 provides an overview of these stages.

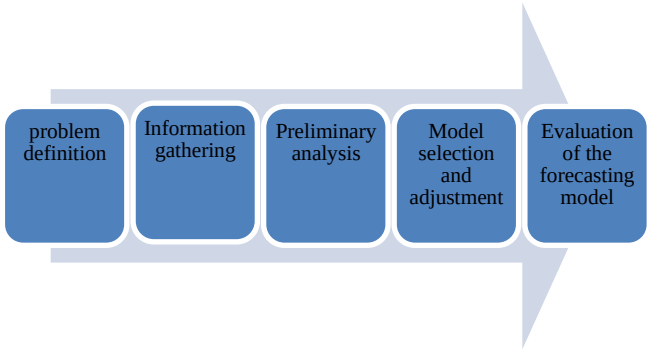

Figure 2: Steps followed in a forecasting process

Each of these steps is an essential link to successfully carry out a forecasting task, and the strength of this process lies in its weakest link:

Step 1: Problem Definition.

This is the most challenging part of the process, which requires answering several questions. This step allows the forecaster to frame the problem accurately and define the objectives of the forecast.

Step 2: Data Collection.

The data collection phase can be faced with difficulties often related to external or internal factors. For example, issues such as limited rights to data usage or the skills of the individuals involved in data collection can arise. In many cases, this part is outsourced to third parties (companies or freelancers), making it challenging for the forecaster to intervene directly.

Step 3: Preliminary (Exploratory) Analysis.

The simplest way is to present the data in graphical form and analyze various aspects of it, such as:

- Consistency of patterns.
- Meaning of trends and seasonality in the data.
- Presence of outliers.
- Relationships between different variables.

Step 4: Model Selection and Adjustment.

The choice of the model is determined by several factors, including the availability of historical data, relationships between the variables to be forecasted and the explanatory variables, and how the forecasts will be utilized. It is common to compare two or three potential models. All models are artificial constructs based on a set of assumptions (explicit and implicit) and generally involve one or more parameters that need to be estimated using known historical data.

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Step 5: Forecast Model Evaluation

Once the model is selected and its parameters and hyperparameters have been estimated, the model is then used to make forecasts. The performance of the model is evaluated based on the forecasts and the test data.

Several methods have been developed to help assess the accuracy of forecasts. The measures used in this part are diverse[10], including:

- MAPE: Mean Absolute Percentage Error.
- RMSE: Root Mean Square Error.
- MAE: Mean Absolute Error.

IV. CONCLUSION

In conclusion, this paper has provided an overview of interactive decision support systems (IDSS) and their significance in various domains. We discussed the components of an IDSS and explored its application in forecasting and planning. The analysis highlighted the importance of IDSS in enhancing interactive decision-making processes and improving overall efficiency. However, it is important to note that there are still opportunities for further research and development in this field, especially with the inclusion of recommendation systems, a novel layer is added to the architecture, supporting the decision maker in their management tasks. As technology continues to advance, we can expect new advancements and innovations in IDSS that will further enhance their capabilities. Overall, IDSS holds great potential for improving decision-making processes and driving organizational success in the future.

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