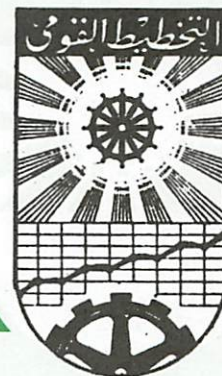


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**Using Intelligent Decision Support
Systems in Selected Aspects of
Health Care**

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Using Intelligent Decision Support Systems in Selected Aspects of Health Care

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Abstract

Research Title

Using Intelligent Decision Support Systems in Selected Aspects of Health Care

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Brief Abstract

The research introduces the need of using agent technologies in assisting and aiding the responsible parties and decision makers during the decision-making process in general and in the Human Organ Transplantation Management “HOTMS” domain in specific. The medical scenario is assumed to be a real application of a decision support system. The research proves that integrating agents with their various types, techniques and interaction abilities in decision support systems generally and HOTM systems especially, can provide a great support to decision makers and help them to make right decisions and solve problems in a highly advanced fashion.

The research also introduces and studies precisely the main definitions and background of all the interdisciplinary related fields, like “Artificial Intelligence”, “Agent Technology”, “Intelligent Decision Support Systems” as well as the Human Organ Transplantation Management System, in order to point to the significance of using the multi-agent technology during the HOTMS.

From one side, the main contribution was represented by introducing the Human Organ Transplantation Management System Structure for the particular case of Egypt. While from the other side it also contributed by introducing, explaining and presenting the proposed Multi-Agent Human Organ Transplantation Management System architecture with its various proposed agent types and roles integrated in the HOTM System. It is assumed that the system will be of great help on the national level as well on the regional level as the HOTMS is considered now one of the most important services to be provided by the government and which has been recently on the spot for development and establishment.

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Using Intelligent Decision Support Systems in Selected Aspects of Health Care

Chapter One

1. Introduction and Overview

Health care is one of the government's major concerns; it has been on the spot recently for improvement, enhancement and development. The health care domain is facing many problems and complications which require efficient planning, decision making, management and problem solving techniques.

The Intelligent Decision Support Systems IDSS in this domain promise to support decision making in the medical industry as a whole. It assists the different parties, health care professionals and providers during the clinical and medical processes as well as the managerial processes. The IDSS have the ability to add main features and facilities that could assist in countless areas of this domain starting from gathering just-in time information, storing and retrieving it, real time processing, online transaction processing, coordinating and communicating, connectivity and global interaction, continuous examining and monitoring, real-time data analysis and diagnosis and many other areas in this domain.

1.1. The Research Problem and Questions

A lot of studies and reports announce that underdeveloped countries and communities are suffering from high birth rates leading up to overpopulation and all associated needs. These needs result in a variety of challenges and problems on different levels and with respect to various dimensions. In Egypt we are estimated to double by the year 2050, i.e. reach a whopping 160 million. So one of the most pressing issues in the Egyptian healthcare domain is the horribly growing number of liver and kidney patients who are in urgent need of organ transplantation surgeries to save their lives. Recently, and according to the ministry of health and population they estimated the liver patients to be around 10 millions, from which one million at least need a new liver through an organ transplantation surgery. As well as a number not to be underestimated of patients who are in need of other organs such as heart or pancreas.

This, lead the Egyptian government to finally take their decision to allow the organ transplantation surgeries by issuing the **"Human Organ Transplantation Management"**, HOTM law after fourteen years of debate, due to the importance of the organ transplantation which stems from the fact that it clearly draws the thin line between life and death. Shortage of such organs raises the mortality and morbidity rates and may as well lead to physical and social complications. They were motivated by the success of organ transplants and the newly developed surgery techniques and medical treatment world wide. One human donor can save one patient, while one human brain-dead donor can save up to eight lives; with his/her eight different organs.

The **HOT** coordination and management is quite a complex process that involves many different organizations, persons, norms and laws. It requires administrative as well as clinical process management. High level of knowledge management, planning/scheduling, coordination and monitoring is also required. The stressing time constraint is a very important aspect due to the nature of the problem. The **HOTMS** contains two main phases; **Procurement** and **Surgery** phase. Each of them includes many managerial and clinical processes which raise challenges and problems during their execution. In addition, there are many parameters influencing the whole process varying from medical, logistical, managerial ... to ethical. The **Matchmaking** and the **Negotiation** processes during the **Procurement** Phases include some of the main challenges facing the **HOTMS** and the human decision makers and medical experts involved in the system.

In this aspect some **Research Questions** and **Issues** have been raised in an attempt to solve them during the following study as follows:

- 1- How should the **Human Organ Transplantation Management System's Structure** -in Egypt- look like and why the researcher believes it will be the most fitting for Egypt ?
- 2- What would be better, an **HOTM** system relying on centralized or decentralized processes?

- 3- Is there any chance for negotiations during the procurement phase?
And how about using **Intelligent Match Making and Negotiation Techniques** !
- 4- One of the main questions is the ability to rely on techniques and technologies from the AI domain generally and the agent technology specifically as a main contributor of an **IDSS** during the **Human Organ Transplantation Management Processes**.
- 5- On which techniques should the decision makers relay in specific when building the proposed **Intelligent HOTM System**. And how should the systems architecture look like?
- 6- Does the proposed intelligent HOT System assure the fairness, effectiveness and efficiency of the allocation process and the whole HOTM Processes?

All these questions have been analyzed, tackled and answered to some extent during the research and in specific in the second part of it during chapter four and five.

1.2. The Research Objectives

The main objectives of the research are to answer and tackle the research questions and try to solve the main problem through proving what follows:

- 1- The importance of using intelligent systems and technologies from its broad concept, in assisting and aiding the responsible parties and decision makers during the decision-making process in general and in the Human Organ Transplantation Management System, **HOTMS** in specific.
- 2- Integrating agents with their various types, techniques and interaction abilities in the HOTM domain provide a great support to decision maker and help them to make right decisions and solve problems in a highly advanced fashion. It also assures an improved degree of autonomy, responsiveness, pro-activeness, mobility, social ability and flexibility.

This will be accomplished through providing and achieving specific objectives like follows:

- **Presenting and introducing** the literature review and definitions of "Intelligence", "Artificial Intelligence" and the "Intelligent Decision Support Systems" as well as introducing various "Intelligent Decision Making" techniques to encourage decision makers and planners to make use of these different technologies under the umbrella of "Artificial Intelligence" to benefit from its advantages during decision making and planning in the healthcare domain generally and its different topics specifically.
- **Encouraging** researchers from interdisciplinary fields to **apply and use** the artificial intelligence technologies and techniques when developing and implementing their intelligent decision support systems
- **To draw** the health care professionals, stockholders, parties and medical specialist's attention to the intelligent systems and techniques used in the health care domain by presenting and defining the intelligent medical and clinical decision making and the classification of the intelligent decision support systems in the health care domain as well as giving some examples and applications in different areas of the domain.
- **Proposing and introducing a Human Organ Transplantation Management's System Structure** to be considered and adopted while establishing the Egyptian HOTM System in the near future.
- **As a proof of concept, proposing and introducing a Multi-Agent HOTM System Architecture** to be considered in Egypt considering it a real application of decision making systems. Providing it guarantees efficiency, effectiveness and high-quality HOTM services. It also should assure fair and safe resource allocation that saves time, effort and money.

In this Aspect, one will proof that there is an urgent need to develop mechanisms and systems that help to decrease the percentage of losses in each phase and process. Therefore it is worth it to elaborate intelligent systems, efficient information systems and tools to be used as decision supporters during the HOTM. These must have some communicative, informative, cognitive and negotiating functions to guarantee secure distributed communication, maintaining

historical information files, and extracting new knowledge from the systems behaviour and from the analysis of the data.

1.3. The Research Importance

Adopting the IDSS and the artificial intelligence techniques in the health care domain promises to improve the domain generally by improving its various medical, clinical and managerial processes, procedures and activities. It has the power to solve some of the common problems and challenges facing the domain.

As mentioned before, the Egyptian government issued the HOTM law to save patients generally and in specific the kidney and liver patients who represent the highest category of people waiting for an organ. Their target is to establish an efficient and effective HOTM system as part of their main plan to improve the whole health care domain.

The research is of great importance at this point in time as it claims that using the multi-agent technology during the Human Organ Transplantation Management will result in effectiveness and efficiency in the whole medical care process. It is a good support and aid for the personnel and decision-makers involved in the system due to the flexible information flows and solutions of the complicated distribution problems. The proposed system could improve some health indicators as follows:

- Reduction of deaths (Mortality Rate) caused by the absence of management of HOT and the scarcity of organs available.
- Increase the number of cured organ failures by increasing the donors organ viability due to effective HOTM
- Decreasing the number of discarded donor organs by facilitating efficient evaluation and negotiation techniques
- Enhancing the effective resource allocation which increases the probability of curing diseases and saving lives
- The importance of the study is also revealed in its relevance to the importance Egypt places on the urgency of establishing and developing the Human Organ Transplantation Management System.

1.4. The Research Approach

The Research will follow a descriptive analytical approach. The problems of the HOTMS will be well studied and tackled to get the best solutions. This will be done by representing a conceptual framework in which the scope is limited due to the scarcity of information and vague vision as it is a very recent issue under development. The main contributing output of the research will be presented by:

- A proposed HOTM system structure for Egypt
- A proposed Multi-Agent HOTM System architecture to be adopted and that can be implemented as a prototype in a following study.

1.5. The Research Outline

The research consists of six chapters divided mainly into two parts. The first part contains chapter one, two and three and represents and introduces the background review of definitions of main topics of "IDSS", "AI and Computational Intelligence", "Intelligent Medical Systems" and the related definitions and aspects. The second part containing chapter four, five and six introduces, represents and explains the proposed Multi-Agent Human Organ Transplantation Management System structure and architecture from all its aspects and concludes with the conclusions, recommendations and contributions. The following is a very brief summary about these chapters:

Chapter **One** consists of the introduction, overview, research problem & questions, objectives, importance and approach.

Chapter **Two**: more or less this chapter is an introductory chapter for non-specialists of Artificial Intelligence. It is mainly addressed to researchers from different disciplines- who read this research- as a compact overview of the AI and DSS fields, techniques, technologies and synergetic systems in an aim to encourage various researchers and experts from other domains to make use of it in order to solve real world problems. Therefore the chapter consists mainly of some related topics with their definitions and background to prove the benefits of using intelligent and agent technology during the health care and medical decision support systems. The topics review the "Intelligence" and "Artificial Intelligence" as a concept as well as the "Intelligent Decision Support Systems". The intelligent

decision-making process, phases, techniques, characteristics and properties will also be introduced, ending up with presenting different “Synergistic Approaches”.

Chapter Three: targets mainly the specialists and researcher in the medical and healthcare domain. It presents the “Artificial Intelligence” and “Computational Systems” in the Clinical and Health care domain by presenting literature review of intelligent medical and clinical decision making, the classification of the intelligent decision support systems in the health care domain giving some examples and applications in different areas of the domain. By that it encourages the decision makers of this domain to try to make use of these intelligent technologies within the healthcare and medical domain believing it could handle many of their problems in an advanced fashion.

Chapter Four: starts the core part of the research by stressing and showing the importance of using agent technology in the Human Organ Transplantation System. It starts by presenting the reasons of success of the HOTM System, and then it defines thoroughly the HOTM phases, processes, influencing parameters, nature and characteristics, challenges and problems. After that it introduces and explains the actual state of the HOTMS in Egypt contributing by proposing an HOTMS definite structure with its different levels or layers for the case of Egypt. How it should be structured, organized and managed. Different aspects of match-making and negotiation processes have been discussed and introduced. At the end the chapter claims the benefits, efficiency and effectiveness of using Multi-Agents during the HOTMS.

Chapter Five: contributes by presenting the proposed Multi-Agent HOTMS processes, architecture, scenarios and integrated agent types and roles. It presents also an overview of a multi-agent system development approach and ends up by introducing general requirements and demands for establishing a reliable, consistent and high-quality multi-agent HOTMS in Egypt.

Chapter Six concludes with the research conclusions, contribution and further work.

Chapter Two

2. The 21st Century: Era of Intelligent Decision Making

One of the main aims of decision making is to select the best possible course of actions, scenarios, solutions or decisions from a set of alternatives to support managerial work as well as the decision making processes. Decision-makers are challenged usually with increasingly stressful environments; highly competitive, fast-paced, near real-time, and overloaded with information distributed data sources, which makes the analysis needed to conclude the best decisions more sophisticated and complex [Wren.2005] [Gupt.2006]. Moreover, real-world information and/or data are often incomplete, ambiguous, complex, containing various kinds of noise due to uncertainties of the environments [Jain.2010].

Although, these challenges and difficulties, and according to “Gloria E. and Lakhmi C. in [Wern.2005] they stated, that the infusion of technology and Internet into our communities and environments in the 21st century has its enormous effect on transferring the landscape of decision making in organizations, institutions and even on the personnel level. And for managers, business executives or decision-makers to cope with the challenges of decision making and take fast decisions, almost in real time there is a tremendous need for decision support tools that can effectively lead to intelligent decision at the moment. The combination of the Internet enabling speed and access, and the maturation of artificial intelligence techniques, led to sophisticated aids to support decision making under risky and uncertain conditions that improve the decision making process by suggesting solutions better than those made by human alone [Wern.2005]. Therefore researchers have designed and developed a variety of advanced decision support systems aids assisting human making decision processes. These aids and techniques stem from artificial intelligence, as well as other complementary methodologies, that are useful for the design and development of Intelligent Decision Support Systems “IDSS” that can be utilized to tackle a variety of real-world problems in different domains and fields; e.g. business, management, manufacturing, transportation, engineering, healthcare, biomedicine... etc [Gupt.2006] [Jain.2010].