Multi-agent system for elderly care:
A primary case study in Morocco

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1 Research Motivation

Hospitals have been an interesting object of research in industrial management for years. On the one hand, the health care system in Morocco is not to be underestimated and further growing economic interest. On the other hand, the healthcare system is a service with complex, varied and significant logistical challenges. Its development requires the resolution of many complex problems potentially having repercussions on the efficiency of all the care services offered to society. The recent health crisis "COVID-19" has shown the need for the use of sophisticated methods to make the system more resilient, robust, and responsive. The objective of optimizing health system is therefore to reduce patient length stay and avoid the congestion in the hospital, while providing high-quality care for aged patients. Those are generally considered as being among the most vulnerable persons in society.

Across the world, in particular in Morocco, the proportion of older persons is projected to grow from 11.5% of the population in 2020 to 15.4% in 2030 [1]. This expanding aged population has resulted in an increasing need for long-term care services for the frail aged. Costs and consumer preference have led to a shift from the long-term institutional care of aged people to home and community based care, a pattern that is anticipated to grow [2]. Consequently, there is a need to put in place new flexible and adaptive concepts and strategies to tackle these challenges, which require the use of scientific approaches and techniques to decision-making and support the various actors (patients, health authorities, political authorities, etc.) in the health system.

2 Problem Statement

In hospital, healthcare professionals are subject to the triple constraints: cost, time, and quality. They must respond to increasing demand for care and satisfy patients while respecting a certain number of logistical constraints. In particular, older patients because they are more than twice as likely to require hospitalization compared with adults in middle age [3]. In addition, the hospital environment is a complex and dynamic system that is characterized by uncertainty. Other challenges that healthcare professionals must take up is to center the health care around the older patient which includes home

care after a hospital discharge. To the best of our knowledge, there is no study that deals with this problem in the Moroccan context. In this research project, we aim to answer two main research questions:

1. How to get a better understanding and manage the in-hospital care of older patients, by analyzing the data and characteristics of older patients?

2. How to proactively help healthcare professionals in managing home care for older patients?

In the literature, most of approaches used in hospitalization management are based on product management approaches, where Patient-centered care production systems can be assimilated to product-centered goods production systems. In addition, these approaches, whether in the industrial or hospital environment, are mainly mathematical models and simulation models using a management approach centered on one or more resources considered critical. However, we must not ignore the presence of the human factor, in the case of care services, which is a main specificity of this research project. This specificity is at the origin of their complex, random and unpredictable character. The properties of agents such as autonomy, communication and proactivity have started to be explored as a management approach in the hospital management [4, 5, 6, 7]. This is why it is interesting to opt for a patient-centered approach based on the multi-agent paradigm to include human factors. We therefore propose a patient-centered distributed multi-agent dynamic system for elderly care. Indeed, multi-agent simulation is one of the most advanced techniques for studying complex systems [8]. It has already proven itself in several fields such as biology, economics, etc. to provide a global and functional view of the system at a high level of abstraction. Unlike classical numerical simulation, this technique is based on the description of the individual behaviors of agents at a micro level.

3   Research Scope

This research thesis is located at the crossroads of simulation and artificial intelligence and aims to:

- Understand the healthcare system by proposing a multi-agent simulator to simulate the system, which will be able to evaluate the performance of actions taken by decision-making entities on the system. It is about modeling and simulating the healthcare system as a complex system including the care pathway (in-hospital care).

- Improve care management by interacting simulation with intelligent decision-making in the system. Indeed, the application of AI techniques will affect several levels and aspects (patient, resource management, etc.). One use case where AI will play a crucial role is to proactively manage the system, for example, adjust capacity regarding older patient flows or define priority cases or assign health professionals to patients at minimum cost in the case of home care.

4   Admission Criteria

The PhD position is proposed by the International Center of Artificial Intelligence of Morocco, of the Mohammed VI Polytechnic University. Applicants with excellent cursus must be holders of a Master's, an engineering or an equivalent recognized degree in Computer Science or Industrial Engineering. In addition, they should have skills in Programming (Python and C++) and good communication skills in English. Particular attention will be given to the suitability of this research project with the applicant's background.

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