Development and modeling of parameter areas of an information system for rehabilitation*

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Abstract
This research presents the results of a comprehensive analysis of the management process and describes the key parameters for the information management system in the field of rehabilitation. This goal is achieved by creating a user-friendly and functional Customer Relationship Management (CRM) system, adding a new component—Training and Rehabilitation Management—along with the necessary technical and software tools to manage patient health during rehabilitation. The system includes the collection, storage, and analysis of information about patients, doctors, rehabilitation specialists, trainers, and their interactions. The research primarily focuses on physical exercises essential for rehabilitation processes. Using a simulation modeling system, the task of distributing patient arrivals over a set time period was modeled. It is important for the department to provide assistance quickly and promptly, and the administrator believes that patients should not wait more than five minutes for a rehabilitation consultation. Patients are served on a "first come, first served" basis and are examined by the first available rehabilitation specialist when their turn arrives. The rate of patient arrivals follows a normal distribution, and the treatment time follows an exponential distribution

Keywords
Relationship management system, rehabilitation, simulation modeling system, a normal distribution

1. Introduction

The aim of this research is to analyze the main stages of activity and optimize the operation of rehabilitation centers to provide better service. The location of centers is determined according to the number of people in need of assistance in each locality.

Rehabilitation can be viewed as a kind of business segment, as gyms and gym networks have become an integral part of every city's life. Regardless of scale—whether it's a small gym or a large network—this sector is growing, and the number of clients and people requiring services is constantly increasing, creating new management challenges. There is a need to optimize management processes, as these institutions bear significant costs for additional staff and resources necessary for effective functioning. Modern information technology can help address these challenges: today, various business management information systems are available, which can be adapted for effective use in rehabilitation. There are three CRM approaches, each of which can be implemented independently of the others:

Operational — automation of consumer business processes, helping customer service staff perform their functions.

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Collaborative — the program interacts with consumers without the involvement of customer service staff.

Analytical — analysis of consumer information for various purposes.

It is important to note that recently, a considerable number of CRM systems have emerged on the information market, including those for gyms. However, many of these systems have several drawbacks in terms of management. The article examines the issue of managing a rehabilitation center in a large hospital, where there is a challenge in providing care to patients who arrive at varying frequencies throughout the day. When needed, four doctors are available to treat patients. If their assistance is not required, they switch to other tasks (such as lab tests, reporting, or X-ray analysis), or their work is rescheduled for another time. The second stage of this research is to analyze and make optimization of emergency department operations in a rehabilitation center and solve task about ensuring quality and timely patient care.

In modern rehabilitation centers, especially large ones, the issue of effectively organizing emergency care processes often arises. Department administrators face the challenge of ensuring a quick response to the arrival of patients who need immediate assessment and assistance. Delays in service can negatively affect patients' conditions and the overall impression of the center's services. The department must ensure that doctors are available for quick response while also making efficient use of their time. When there are no patients, doctors can perform other tasks, such as lab work, reporting, or X-ray analysis. However, when patients do arrive, it's essential that their wait time for a doctor's assessment does not exceed five minutes. A "first-come, first-served" approach to patient care helps reduce waiting time and ensures a consistent care process. To analyze and optimize department workflows, a simulation model was created in the FlexSim software environment. This software enables the modeling of various patient arrival scenarios, adjusting the number of personnel, and testing different task allocation strategies. Using FlexSim has helped identify optimal queue management and resource allocation methods, significantly improving the department's productivity and reducing patient wait times. This article explores the specifics of organizing emergency care operations in a rehabilitation center, optimal doctor allocation strategies, and task scheduling methods that enhance department efficiency. The author also provides an analysis of patient flow during a typical workday and the results of FlexSim modeling, which offer insights into workload distribution among doctors and identify ways to improve service delivery.

2. Related work

Main goals of this research: improving the effectiveness and speed of rehabilitation by creating a convenient and functional CRM system for managing relationships with rehabilitation center patients[1,2]. This includes collecting, storing, and analyzing information about patients, doctors, trainers, and their relationships.

Within this research, the following tasks need to be addressed[3]:

1) Developing a CRM system to automate patient rehabilitation processes, assisting patient care staff in fulfilling their responsibilities

2) Creating an algorithm for loading medical records, storing, and processing patient data to enhance rehabilitation outcomes

3) Studying algorithm anomalies and evaluating the effectiveness of the CRM system

4) Solving the task of modeling the admissions department of a rehabilitation center [4].

Scientific paper [5] examines the relationships between variables in the success of electronic customer relationship management (e-CRM). The article aims to explore the impact of technological readiness, privacy, COVID-19, customer pressure, trust, service quality, and customer satisfaction. We chose this publication because the issue of COVID-19 remains relevant, with many people still at risk.

The research work [6] discussed the automatic tracking and quantitative assessment of physical exercises. This not only helps motivate people towards self-improvement but also promotes better

health. It also examined strength training in addition to aerobic exercises, which is an important component of a balanced exercise program, especially in rehabilitation processes.

Scientific work [7], included in our research, is based on a study whose essence is as follows: the authors suggest presenting some CRM ideas and components, along with the CRM procedure, to take proactive steps regarding client relations with medical institutions and healthcare-related establishments to increase patient satisfaction.

The aim of article [8] is to examine the spread of COVID-19. Related recommendations to stay home and the closure of gyms and fitness centers had a significant impact on health behavior, leading to a general decrease in physical activity. This article examines the outcomes of measures to prevent the spread of COVID-19 and the implementation of alternatives.

Publication [9] describes and dispels advice on exercise and diet that personal trainers provide to their clients from a gender perspective. The article presents the results of research by therapists and trainers regarding gender-based physical demands.

Article [10] presents certain IT solutions in the complex processes of the health industry. The authors highlight those specifically related to physical injuries during production and exercise. Article [11] highlights the challenges faced by sports institutions and others during the pandemic, describing solutions to many emerging problems.

As a result of the conducted analysis of the sources used, several types of CRM systems were selected, which we relied on in the course of our research.

2.1. Analysis of Key Components and Data for Operating a CRM System for a Rehabilitation Center

Improving the efficiency and speed of rehabilitation by creating a convenient and functional CRM system for managing relationships with patients at a rehabilitation center, including the collection, storage, and analysis of information about patients, doctors, trainers, and the interactions with them are main goals for creating CRM System with including all nesesary components. This study aims to address the following tasks:

- developing a CRM system to automate patient rehabilitation processes, assisting staff in fulfilling their roles with patients
- designing an algorithm for loading medical records, storing, and processing patient data to enhance rehabilitation process effectiveness
- dnvestigating algorithm anomalies and evaluating the CRM system software's efficiency

2.2. The dependences between different components in CRM system for rehabilitation

The main features of CRM that we propose will include:

Brand and Location Management: This module will allow for the creation and configuration of various brands and locations for gyms and rehabilitation centers to better manage their operations and resource allocation.

Client Management: This module will store and process client information, including contact details, medical history, past training sessions, and future plans.

Staff Management: This module will enable staff management, allowing the addition of new trainers and rehabilitation specialists, integrating them into records, and tracking business activities. Training and Rehabilitation Management: This module will provide trainers and rehabilitation specialists with guides for client training based on their medical history.

Scheduling Management: This module will allow clients to book appointments at specific locations, with specific trainers or rehabilitation specialists, as well as track their schedules.

Reporting and Analytics: This module will enable administrators to access and analyze statistics to assess the effectiveness of both client and staff activities. For example, they can view statistics for a specific location or an entire brand.

Wishlist: This module will allow potential clients to submit requests to the brand. Due to the nature of this project, not all clients will be able to visit the location in person, so they can leave their information along with a request.

The system will have roles to ensure each employee can view and manage only what is allowed. The roles include:

OWNER
ADMIN
COACH
RECEPTIONIST

Each of these roles has specific permissions and limitations. The OWNER serves as the brand owner and has access to the full functionality provided by the system.

2.3. The CRM architecture with the main components and interactions of the rehabilitation system

To use the system, the owner must first register. Once registered, several functions become available, such as viewing the directory of trainers and rehabilitation specialists and adding a new brand (Figure 1).

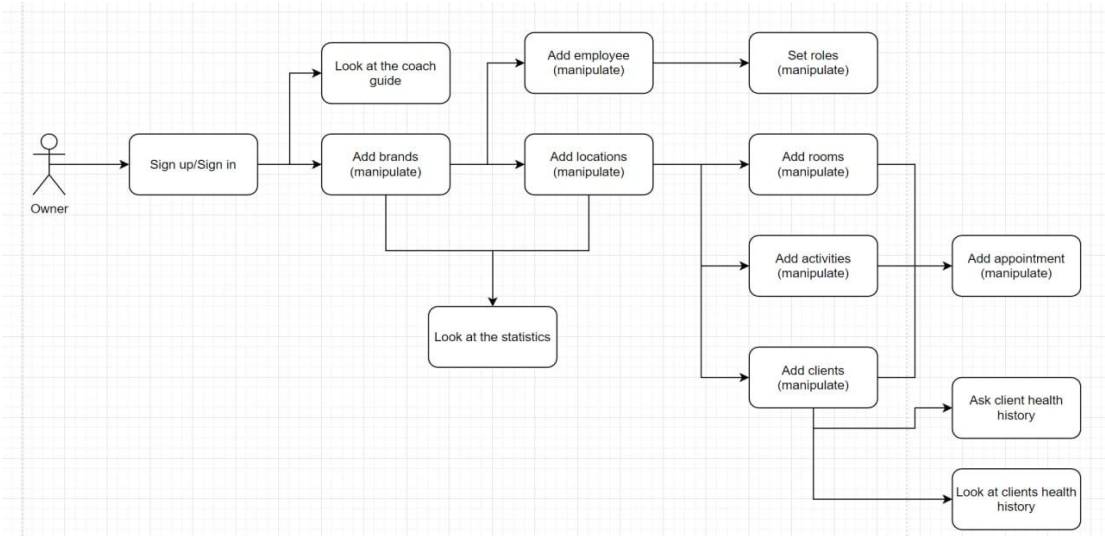

Figure 1: Owner Capability Diagram

After adding at least one brand, the owner can then add brand locations and assign employees, who will subsequently be able to use the system. When adding employees, the owner can assign them one or more roles, which will determine their access to specific functionalities. Upon adding a brand, the user will see statistics, which will initially display as zero. Once the owner adds one or more locations, they can set up rooms (training halls) for each location, add activities for the location, and add clients. Once a client and activity are assigned to a location, the owner will be able to schedule the client.

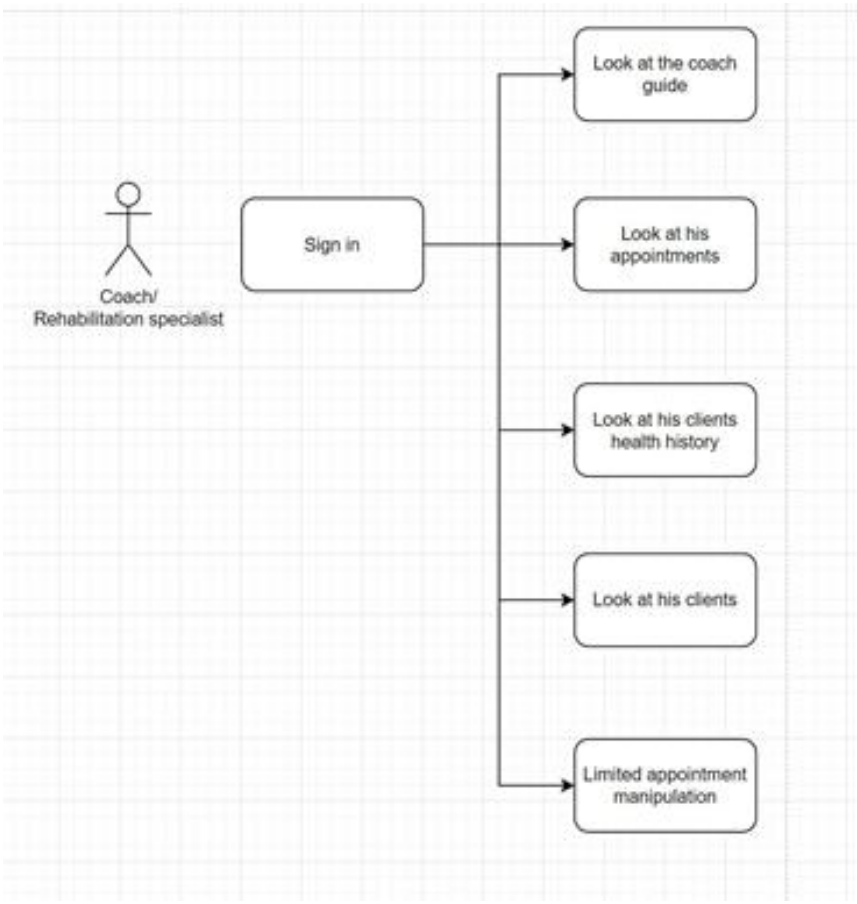

Figure 2: Rehabilitation Specialist Capability Diagram

Additionally, the owner will have access to the client's medical history. The new module we are proposing is precisely a functionality that provides management for training and rehabilitation. Training and Rehabilitation Management: This is a new module absent in well-known rehabilitation CRM systems that we analyzed. It enables trainers and rehabilitation specialists to find training guides for clients based on their medical history. I haven't seen this capability in any comparable systems. It is a list of guides retrieved from a database, which can be filtered by physical impairments.

3. Modeling the process of patient arrivals at rehabilitation stations

An important issue is the study of data regarding the regulation of patient inflow to the rehabilitation specialist and ensuring even distribution [12-16]. We examined the task of distributing the number of patients within specified time intervals Table 1. It is useful for the Rehabilitation Department to provide assistance quickly and promptly, and the administrator believes that patients should not wait more than five minutes to see a doctor. Patients are served on a "first-come, first-served" basis and are examined by the first available doctor when their turn comes [13]. The pattern of patient arrivals on a typical day is as follows:

Table 1
Patient Arrival Intensity

Hours	Patient Arrival Rate

9 am – 15 pm	6 patients per hour
15 pm – 20pm	4 patients per hour
20:00–midnight	12 patients per hour

The rate of patient arrivals follows a normal distribution with a coefficient of variation of 20%, and the treatment time, averaging 12 minutes, follows an *exponential distribution.*

Allocate rehabilitation therapist working hours across each period to serve the expected number of patients while aiming to equally distribute the workload among all rehabilitation specialists as much as possible. In modeling a flow line, quantities distributed according to the normal law are also needed. To achieve this, we will consider a standard Gaussian random variable. The distribution function of the standard *normal law*(1):

$$\Phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} e^{-\frac{x^2}{2}} dx \tag{1}$$

Figure 3 shows the specified input parameters for the initial station and the projected number of patients who may arrive at a given station within the corresponding specified time interval.

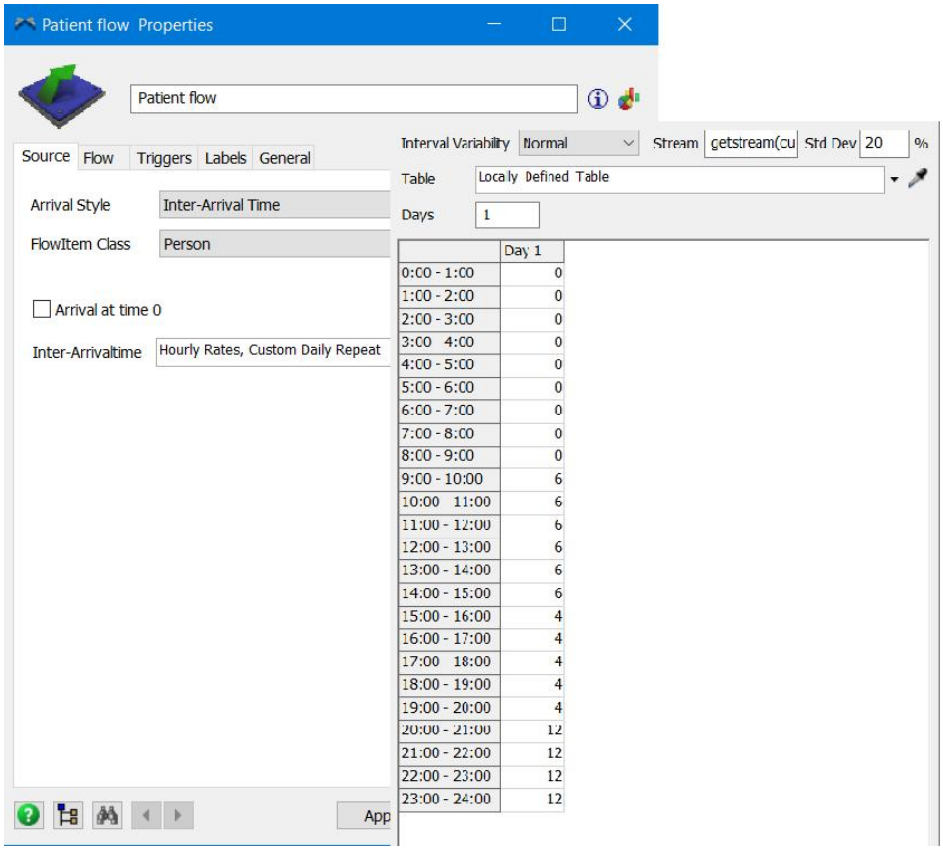

Figure 3: Input parameters of patients for the corresponding time interval

We have proposed a simulated process, using simulation modeling, for distributing patients among rehabilitation specialists' offices within a specified time interval.

4. Results

Using the FlexSim simulation modeling environment [12], the process of patient distribution relative to the given criteria was modeled, where the intensity of patient arrivals follows a normal distribution with a quadratic coefficient of variation of 20%, and the treatment time, averaging 12 minutes, follows an exponential distribution. The task is to allocate the doctors' working time during each period in such a way that assistance is provided to the expected number of patients, while also aiming to evenly distribute the workload among the doctors. The obtained statistical results of the even distribution are shown in the graphs depicted in the Figure 4.

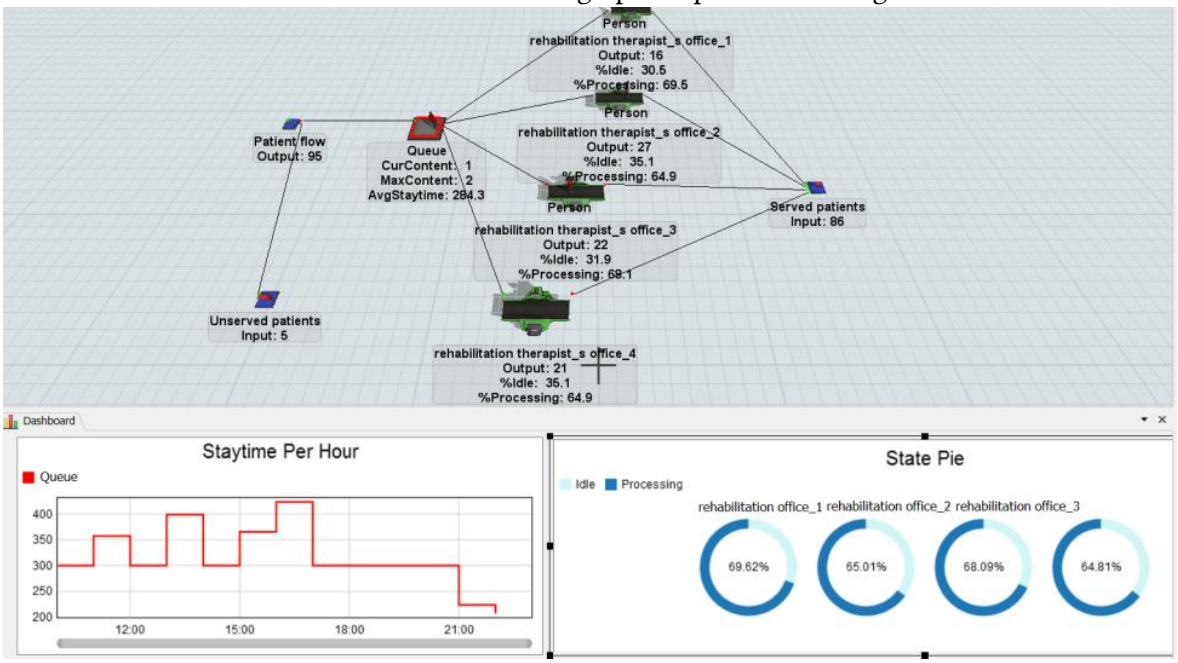

Figure 4: Data analysis for each element of the model component for distributing patients to rehabilitation therapists.

As a result of the distribution, we obtained charts showing the arrival of patients at the rehabilitation stations and their even distribution, which are depicted in Figure 4 in the State Pie charts which demonstrates the even distribution of patients across the four stations.

5. Summary and Conclusion

In conclusion, this research successfully demonstrates the development of an integrated information management system tailored to the rehabilitation field. By creating a user-friendly and functional CRM system with the addition of Training and Rehabilitation Management components, this approach enhances the efficiency and effectiveness of patient care during rehabilitation. The system's ability to collect, store, and analyze data on patients and healthcare professionals ensures a seamless flow of information, supporting informed decision-making. Additionally, the simulation modeling of patient arrival and treatment times illustrates the system's capacity to optimize resource allocation and reduce wait times, ensuring prompt and efficient service. Ultimately, this research contributes to improving rehabilitation management by leveraging technology to streamline processes and enhance patient care outcomes.

6. Declaration on Generative AI

In the process of preparing this paper, the authors utilized ChatGPT and Grammarly to identify and correct grammatical errors, typographical errors, and spelling problems. After using these tools, the authors have carefully reviewed and edited the content as needed and take full responsibility for the final publication.

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