A market intelligence model for the health care business system

Um modelo de inteligência de mercado para o sistema empresarial de assistência médica

Un modelo de inteligencia de mercado para el sistema empresarial de atención médica

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ABSTRACT
Health in Brazil is an old problem that has worsened with the Covid-19 pandemic and resources have become scarce. Studying market behavior and growth trends has become fundamental. This research aims to build a Market Intelligence Model, based on information obtained from official secondary data sources, using the Fuzzy logic methodology. The concepts of Data Analytics and Decision Making applied in the Health Area are addressed. The model was developed in RStudio software, stored in SQL Database, and presented in Power BI and QGis. The model was validated in private health units in the southeast and northeast regions of Brazil for the treatment of chronic diseases, mainly in the areas of nephrology and oncology. The results were obtained, and it can be concluded that the proposed model has become very effective in estimating the growth of chronic diseases.

Keywords: market intelligence, Fuzzy Logic, data analytics, decision making, healthcare.

RESUMO
A saúde no Brasil é um problema antigo que piorou com a pandemia da Covid-19 e os recursos se tornaram escassos. Estudar o comportamento do mercado e as tendências de crescimento tornou-se fundamental. Esta pesquisa visa construir um Modelo de Inteligência de Mercado, baseado em informações obtidas de fontes de dados secundárias oficiais, usando a metodologia lógica Fuzzy. Os conceitos de Análise de Dados e Tomada de Decisão aplicados na Área de Saúde são abordados. O modelo foi desenvolvido no software RStudio, armazenado no Banco de Dados SQL e apresentado no Power BI e QGis. O modelo foi validado em unidades privadas de saúde das regiões Sudeste e Nordeste do Brasil para tratamento de doenças crônicas, principalmente nas áreas de nefrologia e oncologia. Os resultados foram obtidos e pode-se concluir que o modelo proposto se tornou muito eficaz na estimativa do crescimento de doenças crônicas.
Keywords: inteligência de mercado, Lógica Fuzzy, análise de dados, tomada de decisão, saúde.

RESUMEN
La salud en Brasil es un viejo problema que se agravó con la pandemia de Covid-19 y los recursos escasearon. Estudiar el comportamiento del mercado y las tendencias de crecimiento se ha vuelto esencial. Esta investigación tiene como objetivo construir un Modelo de Inteligencia de Mercado, basado en información obtenida de fuentes de datos secundarios oficiales, utilizando la metodología de lógica Difusa. Se abordan los conceptos de Análisis de Datos y Toma de Decisiones aplicados en el Área de Salud. El modelo fue desarrollado en el software RStudio, almacenado en la Base de Datos SQL y presentado en Power BI y QGIS. El modelo fue validado en unidades de salud privadas de las regiones Sudeste y Nordeste de Brasil para el tratamiento de enfermedades crónicas, principalmente en las áreas de nefrología y oncología. Se obtuvieron los resultados y se puede concluir que el modelo propuesto se ha vuelto muy efectivo para estimar el crecimiento de enfermedades crónicas.

Palabras clave: inteligencia de mercados, Lógica Difusa, análisis de datos, toma de decisión, salud.

1 INTRODUCTION

Due to the great competition in today's world, companies are seeking to develop strategic projects in order to make faster and more assertive decisions. In the health area, this is more significant, because, in addition to the benefits of management, the more information we collect, the better the construction of a differentiated service to patients will be. It is a comprehensive and careful study that reflects the entire structure of clinics and hospitals, supporting different areas to anticipate market trends.

With the appearance of the Covid-19 pandemic in early 2020 and the drain of resources caused at hospitals and Clinics Worldwide, more than ever there has been noticed a need to improve the business system of hospitals and Clinics. Understanding the changes in the health market is essential for hospitals and clinics to be strategically structured. Another point to note is the growth of population aging, which generates an increase in chronic diseases. The population around the world is living longer, according to the World Health Organization (WHO). The world population over 60 years old will increase from 12% to 22%, and the expectation is that in 2050, 80% of the elderly will live in low- and middle-income. The number of people over the age of 60 will reach 2.1 billion people by 2050, i.e., one-fifth of the world's population.
The importance of identifying, analyzing, and correlating data to generate assertive market growth projections is essential for hospitals and clinics to create physical and financial structures for this new reality, efficiently and quickly serving patients.

The relevancy of this research and the study of this model is also due to the fact, that it be applied to the Brazilian health sector market, (i) Brazil was of the 3rd countries most affected by the pandemic in the number of cases, according to the World Health Organization there were 37.020.531 confirmed cases (Coronavirus – Brazil, 2023). (ii) Although the government offers health to the entire population, the public system does not support the number of people who qualitatively need care, and the country needs supplementary health, which represents an important pillar of the Health System.

The health organization in Brazil is composed of public and private systems, but the Brazilian Constitution guarantees that "Health is the right of everyone and the duty of the State." (Brazil, 1988, Art.196) So, both systems, private and public, coexist in Brazil where the public network is carried out through the Unified Health System (SUS), financed by public resources, derived from government revenues, and the private system is represented by private payers, which are not linked to the SUS, but who are legality subject to an inspection of public authorities carried out by the National Supplementary Health Agency (ANS). Nowadays, in Brazil, while 78 percent of the population uses the Public System, people can use the public or private system, or both simultaneously. However, the 22% of the market size of the Brazilian private sector is huge, one of the biggest in the globe, representing 5.3% of the GDP of Brazil. According to ANS data, there are about 50 million users, 179 billion in revenue in the year 2022, and 692 operators across the country (ANS, 2023).

The present study addresses the construction of a model of market intelligence applied to the Brazilian Private health system, which could significantly improve the management performance of clinics and hospitals. Also, it enhances the care and quality of life of patients. It is a constructions mathematical model of market trends, with projections of the number of patients, disease evolution, mapping of competitors, and coverage of private payers. As in the health area, we deal with many inaccuracies and uncertainties, fuzzy logic was used to build the model, which represents in mathematical terms imprecise information based on a set of rules. Data Analytics techniques were also used to address market information, diseases, patient behavior, trends, and competitors. With this information, clinics and hospitals can plan their next steps and get to know their
patients and competitors better, improving decision making. Making decisions with accurate information helps to minimize risks and improve the result.

1.1 APPLICATION OF THE MODEL

The model was applied to chronic non-communicable diseases, which are responsible for 70% of the causes of death in the world according to the WHO. Chronic diseases are those that persist for a long period, are generally considered to be longer than a year, and require special and constant care. The chronic diseases that were tested in the model were those related to cancers and kidney diseases. Chronic diseases are associated with risk factors such as Obesity, Diabetes, Hypertension, High Cholesterol, Ingestion of alcohol in large quantities, Smoking, Sedentary lifestyle, Stress, genetic inheritance, Sex, Ethnicity, Age, and HDH. Age is one of the most important factors, there is a direct relationship between aging and an increased risk of developing chronic diseases. The HDH (Human Development Index) is another key factor, as disclosed by the WHO, in low- and middle-income countries 82% of people died prematurely, or before reaching 70 years of age.

2 THE ACADEMIC FOUNDATION

The objective of this research is to create a market intelligence model that brings together the five concepts selected for this study: Market Intelligence, Data Analytics, Fuzzy logic, Healthcare area, and Decision Making, as represented in Picture 1. Market Intelligence is a strategic field that maps and anticipates trends using Data Analytics, which transforms data and information into knowledge, which is used with along with Fuzzy logic, and, applied in the Healthcare Area, builds the prediction of diseases, patients, and competitors, faster and more accurately, and can improve Decision making impacting patient care and operational efficiency.
Market intelligence, also called by some authors Competitive Intelligence or Intelligence of the competitor, focuses on external factors to obtain information on the market in which it operates or intends to operate, trends, size, and competition in the market. Nowadays, there are several studies of market intelligence applications in the health area. However, all these research approaches each of these topics separately. The proposal is to build a tool that would apply the concepts and techniques of market intelligence and data analytics in order to improve the management of clinics and hospitals and the care and quality of life of patients. Such market intelligence business models for healthcare systems dynamically optimize resources and greatly facilitate some decision making.

Market intelligence is a strategic tool, where the information and data collected need to be stored, processed, and analyzed to generate powerful information and predictive analytics to support decision making. Along with the concept of market intelligence, it is important to mention data analytics aimed at market intelligence, especially with the large volumes of current data and information. It is essential to use this data for decision making benefits.

Market Intelligence has a fundamental role in organizations. Also known as Competitive intelligence is increasingly considered an important, if not mandatory, piece of every business's overall strategy and functioning. (McGonagle Jr., J. John, M. Vella Carolyn, 2004). As Jamil (2013) defines it, Market Intelligence is a "process designed to
constantly produce knowledge for business sectors from dispersed data and information for strategic market positioning, as an organizational continuum that aims to answer typical decision problems faced by firms when competing in actual business environments.” (p. 464).

The model was tested and validated in clinics and hospitals of the private health system, but data from the public and private systems were used since the entire Brazilian population is registered in the public health system. Through the concepts of Market Intelligence and Data Analytics, patients, diseases, and competitors were mapped, and, using the fuzzy methodology, a mathematical model was created capable of projecting the market, improving decision making in new investments, expansions, and projects of improvements in clinics and hospitals.

2.1 RESEARCH QUESTION AND HYPOTHESES

The objective of this research was to build a mathematical model using market intelligence concepts and techniques, data analytics, and fuzzy logic to manage patient, disease, and competitor projections. This has been tested to see if it can provide improved management and decision making in clinics and hospitals and improved patient care. So, this study presents the following research question: Does the fuzzy logic methodology intelligence model approach help healthcare businesses predict tendencies and better management?

2.1.1 Hypotheses

The following hypotheses were investigated:

H1: The IM model allows for better management and consequent decision making
H2: The MI model makes it possible to predict market trends in advance through growth projection
H3: The MI model allows to improve the treatment and care of the patient
H4: The MI model allows you to monitor competitors.
H5: The growth projection is essential for faster and more assertive decision making.
2.2 FUZZY LOGIC

The theory of classical logic of sets analyzes the classes of objects and their relations in a defined interval, while in Fuzzy Logic the pertinence of an element to the set refers to the fact that such element belongs or not to that set. In contrast to a traditional fuzzy membership function, the range is not limited to \([0, 1]\), but extended to the unit circle in the complex plane. Thus, the complex fuzzy set provides a mathematical framework for describing membership in a set-in term of a complex number (Ramot et al., 2002). As Dos Santos e et al. (2020) noted, there is a gradation of degrees of truth varying between belonging and not belonging, reducing the loss of information and better reflecting reality.

Fuzzy logic is a tool that helps decision making for the composition of patient projections. The Fuzzy tool was implemented in the RStudio software. For the development of the fuzzy control system, we used the main components: fuzzification, inference, fuzzy rules, and defuzzification.

Fuzzy sets were constructed using three input variables, with the only output variable being the patient projection. From these sets, a matrix composed of three rules was developed and included in the RStudio software.
The model was applied to chronic diseases and the area of nephrology and oncology was chosen, which were areas of greatest need in the clinics and hospitals that participated in the validation of the model.

The rule base of a fuzzy system establishes a relationship between the independent variables, and they are used to associate terms based on premises, with the aim of creating a statement (Junior et al., 2020). For the nephrology area, the following rules were used for the implementation of the model, considering the variables obesity, diabetes, and hypertension: (i) If Obesity is high, Diabetes is medium, and Hypertension is medium, so the growth is high; (ii) If Obesity is high, Diabetes is medium, and Hypertension is normal, so the growth is normal; and (iii) If Obesity is low, Diabetes is low, and Hypertension is normal, so the growth is low.

Picture 3 shows the pertinence functions, where BMI (body mass index) input values from 25 to 50 are presented on the X axis, and the Y axis, and the degree of relevance varies from 0 to 1. The overlap that we can observe in Picture 3 is due to the degree of uncertainty that the fuzzy logic presents.

Picture 4 the Glycemia input values from 80 to 200 are presented on the X axis, and on the Y axis, the degree of relevance varies from 0 to 1.
Picture 4: Membership functions from input variable "Diabetes" (hemodialysis)

![Membership functions from input variable 'diabetes']

Source: author's own graphic in RStudio software

Picture 5: Membership functions from input variable "Hypertension" (hemodialysis)

![Membership functions from input variable 'hypertension']

Source: author's own graphic in RStudio software

As for the oncology area, the model was built for the 6 (six) most frequent types of cancer in the units that participated in the validation of the model: Lung; Skin, Stomach, Breast, Prostate, and Uterus.

2.3 SAMPLE AND DATA COLLECTION

For the preparation of this study, primary and secondary data were used. Primary data was collected through research questionnaires and secondary data through as following official secondary data sources: CNES (National Health Registry), DataSUS/Tabnet, ANS (National Supplementary Health Agency), IBGE (Brazilian Institute of Geography and Statistics), WHO (World Health Organization), INCA (National Cancer Institute), body of the Ministry of Health, SBN (Brazilian Society of Nephrology).

After collecting and analyzing secondary data, a database was created in SQL with information on clinics, hospitals, patients, diseases, competitors, and private payers.
related to the field of nephrology and oncology. The data extracted include population demographics, HDI, age, and income, plus private payers penetration, information on health facilities, location of public and private patients, 5-year patient growth, data on patients with obesity, hypertension, diabetes, smoking, genetic factor, age, region/climatic variation, alcohol, and sedentary lifestyle.

3 MARKET INTELLIGENCE MATHEMATICAL MODEL

First, we analyzed the method that health establishments used to project their patients and analyze the market. Then, we studied the historical growth of public and private patients with chronic kidney disease and the following types of cancer: lung, skin, stomach, prostate, breast, and uterus, in the last five years in all 5,568 Brazilian municipalities. In this analysis, we determine the CAGR of growth over the last 5 years that will be used to delimit the range of expected growth.

The variables associated with the incidence of each of the specialties were then selected according to the main risk factors. Afterwards, the fuzzy methodology was applied using the RStudio software, presenting as output the percentage of growth for each rule applied. A scale was created to arrive at the percentage of growth per incidence. This percentage was applied to the database collected from DataSus/Tabnet and ANS in order to arrive at the projected monthly patient growth curve.

3.1 MODEL IMPLEMENTATION

The model was implemented for the area of nephrology and oncology, areas of greatest need for the clinics and hospitals that participated in the research. As mentioned, the model was developed in the RStudio software and SQL database, and as Output, the modules were developed in QGIS software (for a geographic view) and PowerBI (for a managerial view).

For oncology, six models were developed for the most incident types of cancer in Brazil: Lung, Skin, Stomach, Breast, Prostate, and Uterine. Picture 6 shows the initial screen with the four main market data in relation to Brazil: i) Brazilian population; ii) Oncology Establishments; iii) HDI (Human Development Index); iv) % penetration of private insurance in the 5,568 Brazilian municipalities.
Picture 6: Proposed model for Oncology - Market Data

Picture 7 shows lung cancer data, where data from public and private patients by city appears on the left of the screen; on the right of the screen, the growth history of the last five years, and in the center of the screen, the growth suggested by the proposed market intelligence model, which shows a more specific analysis based on variables.

Picture 7: Proposed model (lung cancer) - Main Page

The screen in Picture 8 shows the variables chosen to estimate lung cancer case growth: Age, Genetic Factors, and Smoking.
Picture 8: Proposed model (lung cancer) - Variables

Source: author's own screen in PowerBI Software

Picture 9 shows the mapping in the QGis software of the Health Units and their respective patients, for the 5,568 Brazilian cities. 63% of the units serve only private patients, 26% serve only the public and 11% serve the public and private simultaneously.

Picture 9: Health establishments that provide the oncology service

Source: author's own map in QGis software

4 THE EMPIRICAL RESEARCH AND VALIDATIONS

The model was applied in Clinics and Hospitals of the private health system in Brazil, in two health areas: i) Nephrology and ii) Oncology, As already mentioned were areas of greatest need in the clinics and hospitals that participated in the validation of the model. In the area of Nephrology, the model was applied in two hemodialysis clinics and
one hospital in the acute hemodialysis unit; in the area of oncology, it was applied in two oncology clinics and a hospital.

4.1 APPLICATION TO THE NEPHROLOGY AREA

The model developed for the area of nephrology, was implemented and used by unit managers for a few months, together with the research generated, an analysis and comparison were also carried out between the projection used by health establishments, which is mostly based on historical growth, and the proposed model using the concepts of market intelligence, data analytics with the fuzzy methodology.

4.2 COMPARISON BETWEEN MODEL RESULTS

Comparison was made between (i) the projection used by health establishments, (ii) the proposed new model, and (iii) the model published from January 2022 to December 2022. The model that the units used in clinics and hospitals were based on the historical growth of the last year, which for hemodialysis the growth was 2.48% per the base year 2020/2021. The proposed model was calculated based on the growth of each variable (obesity, hypertension, and diabetes) through the Fuzzy methodology and additionally considering the percentage of obese, hypertensive, and diabetic patients who are on dialysis. The graph in Picture 10 compares the results obtained, in the number of hemodialysis patients between i) The projection that health establishments that participated in the survey used, (ii) The proposed new model, and (iii) The one carried out, for the period of January 2022 to December 2022.
We can see in the graph that in the proposed Market Intelligence model, the projection of patients is very close to the actual one and follows the seasonality of the curve over the months. The projection used by the health units was 2.7% below what was realized in the year.

4.3 APPLICATION TO THE ONCOLOGY AREA

Two clinics and an oncology hospital were chosen. A clinic located in the city of Niterói and a group of 6 clinics located in the city of São Paulo, both in the southeast region, was chosen. The chosen hospital is located in the city of Recife, located in the northeast region of Brazil, the average attendance per month is 2,040 patients in the clinics, and in the hospital 40 patients at the bedside.

4.4 COMPARISON BETWEEN MODEL RESULTS

The projection used in clinics and hospitals was based on the historical growth of the last year, for skin cancer the growth was 7.35% per base year 2020/2021.

The graph in Picture 11 compares the results obtained, in the number of skin cancer patients: (i) The projection that the health establishments that participated in the
research used, (ii) The proposed new model, and (iii) The one carried out, for the period from January 2022 to December 2022.

![Model comparison graphic for oncology (skin cancer)](source)

The proposed Market Intelligence model, the projection of patients is very close to the actual one and follows the seasonality of the curve over the months. The projection used by the health units was 6.8% below what was realized in the year.

### 5 VALIDATION OF THE PROPOSED RESEARCH MODEL

This study applies the structural equation modeling method, and the data was analyzed using Partial Least Squares (PLS), where its parameters were estimated through a series of least squares regressions. The SmartPLS software (v.3.3.9) was used, and the following steps were developed: Path diagram; Evaluation of measurement models (Confirmatory Factor Analysis, Extracted Mean Variance, and Cronbach's Alpha and Discriminant Validation), and Validation of the paths or structural model through Pearson's Coefficient of Determination ($R^2$).

The PLS Algorithm was calculated and presented in Picture 12:
A low factorial load was observed in some indicators of the model, the indicators that presented a load lower than 0.500 were excluded. Some analyses load less than 0.700 but due to the small sample (seven respondents), it was considered more than 0.500. The following indicators with low load: DM1, DM2, DM5, MI2, MI3, MI4, MI5, CP3, CP5, GP1, CP2, CP4, PC2, PC4, and PC5 were eliminated and the PLS Algorithm was executed again, generating the diagram in Picture 13:
The diagram in Table 1 is composed of latent variables, with the following values for $R^2$:

<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitors</td>
<td>0.260</td>
</tr>
<tr>
<td>Decision Making</td>
<td>0.900</td>
</tr>
<tr>
<td>Growth Projection</td>
<td>0.852</td>
</tr>
<tr>
<td>Patient Care and Treatment</td>
<td>0.589</td>
</tr>
</tbody>
</table>

Source: author’s own table

5.1 CONSTRUCT RELIABILITY AND VALIDITY

After excluding variables with low factorial loading, the Bootstrapping Algorithm, for 500 subsamples, generating Table 2 below, which shows the results of the model with factor loading, Cronbach's alpha coefficient, rho_A coefficient, composite reliability, and mean-variance extracted for each construct, using the matrix of correlations, where the diagonal values are the square root of the extracted variance since they are greater than the correlations between the latent variables (off-diagonal values), ensuring validity.

Table 2: Discriminant validity - Values of correlations between latent variables and square roots of the mean-variance drawn on the main diagonal

<table>
<thead>
<tr>
<th>Latent variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitors</td>
<td>0.700</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision Making</td>
<td>0.601</td>
<td>0.833</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Projection</td>
<td>0.756</td>
<td>0.926</td>
<td>0.805</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model M</td>
<td>0.510</td>
<td>0.934</td>
<td>0.923</td>
<td>0.905</td>
<td></td>
</tr>
<tr>
<td>Patient Care and Treatment</td>
<td>0.413</td>
<td>0.768</td>
<td>0.738</td>
<td>0.767</td>
<td>0.971</td>
</tr>
</tbody>
</table>

Cronbach's Alpha  
Rho_A  
Composite Reliability  
Average Variance Extracted (AVE)

Source: author’s own table

We also observed that the variable Cronbach’s Alpha > 0.7 for the majority guaranteeing reliability between the indicators of each construct, Composite Reliability > 0.7; Cronbach’s alpha < rho_A < Composite Reliability to verify the reliability of construct scores and AVE > 0.5 ensuring convergent validity.
5.2 CROSS LOADINGS

Cross loadings are another criterion for evaluating discriminant validity. Table 3 presents the indicators and their factor loadings. We can observe that the majority of factor loadings present higher values in their constructs, demonstrating the discriminant validity.

Table 3: Discriminant validity - Verification of the existence of cross loads

<table>
<thead>
<tr>
<th>Competitors</th>
<th>Decision Making</th>
<th>Growth Projection</th>
<th>Model Mi</th>
<th>Patient Care and Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP1</td>
<td>0.887</td>
<td>0.531</td>
<td>0.656</td>
<td>0.347</td>
</tr>
<tr>
<td>CP2</td>
<td>0.924</td>
<td>0.537</td>
<td>0.718</td>
<td>0.594</td>
</tr>
<tr>
<td>CP4</td>
<td>0.523</td>
<td>0.363</td>
<td>0.372</td>
<td>0.224</td>
</tr>
<tr>
<td>DM3</td>
<td>0.596</td>
<td>0.910</td>
<td>0.925</td>
<td>0.939</td>
</tr>
<tr>
<td>DM4</td>
<td>0.279</td>
<td>0.741</td>
<td>0.550</td>
<td>0.553</td>
</tr>
<tr>
<td>GP3</td>
<td>0.556</td>
<td>0.918</td>
<td>0.927</td>
<td>0.930</td>
</tr>
<tr>
<td>GP5</td>
<td>0.706</td>
<td>0.658</td>
<td>0.665</td>
<td>0.445</td>
</tr>
<tr>
<td>MI1</td>
<td>0.599</td>
<td>0.916</td>
<td>0.925</td>
<td>0.939</td>
</tr>
<tr>
<td>MI6</td>
<td>0.278</td>
<td>0.754</td>
<td>0.718</td>
<td>0.808</td>
</tr>
<tr>
<td>PI1</td>
<td>0.389</td>
<td>0.662</td>
<td>0.631</td>
<td>0.687</td>
</tr>
<tr>
<td>PI3</td>
<td>0.456</td>
<td>0.766</td>
<td>0.800</td>
<td>0.795</td>
</tr>
</tbody>
</table>

Source: author’s own table.

The Table 4 shows Pearson's Coefficient of Determination Qualification: $R^2$.

Table 4: Pearson's Coefficient of Determination Qualification

<table>
<thead>
<tr>
<th></th>
<th>$R^2$</th>
<th>$R^2$ Ajustado</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitors</td>
<td>0,260</td>
<td>0,112</td>
</tr>
<tr>
<td>Decision Making</td>
<td>0,900</td>
<td>0,850</td>
</tr>
<tr>
<td>Growth Projection</td>
<td>0,852</td>
<td>0,822</td>
</tr>
<tr>
<td>Patient Care and Treatment</td>
<td>0,589</td>
<td>0,506</td>
</tr>
</tbody>
</table>

Source: author’s own table

As the $R^2$ values for the research constructs have a considered large effect, greater than 26%, indicating good model quality.

5.3 RESULTS AND STATISTICAL ANALYSIS

In the study, five research hypotheses were proposed and all were supported. The Table 5 shows the path coefficients (PC) that were determined by the SmartPls software, indicating the statistical significance of the relationships between hypotheses H1, H2, H3, H4, H5 in the research model.
Therefore, we can state in relation to the hypotheses that:

Hypothesis H1 – The relationship between the MI Model and Decision Making has significant statistical significance for strong, as p path coefficient is 0.534. So, the Hypothesis is accepted, that is, the MI model allows better management and consequent decision making.

Hypothesis H2 – The relationship between the MI Model and Growth Projection has strong statistical significance, as p path coefficient is 0.923. So, the Hypothesis is accepted, that is, the MI model allows for predicting market trends in advance through growth projection.

Hypothesis H3 – The relationship between the MI Model and Patient Care and Treatment has strong statistical significance, as p path coefficient is 0.767. So, the Hypothesis is accepted, that is, the MI model allows to improve the treatment and care to the patient.

Hypothesis H4 – The relationship between the MI Model and Competitors has significant statistical significance for strong, as p path coefficient is 0.510. So, the Hypothesis is accepted, that is, the MI model allows monitoring competitors.

Hypothesis H5 – The relationship between Model MI, Growth Projection and Decision Making has statistically relevant significance for strong, the path coefficient is 0.433. So, the Hypothesis is accepted, that is, the growth projection is fundamental for faster and more assertive decision making.

The proposed model was submitted to validity tests and the five hypotheses were tested using the SmartPLS software, and the results confirmed and validated the proposed research model.

6 CONCLUSIONS

This research was carried out using as a theoretical framework the concepts of Market Intelligence, Data Analytics, Fuzzy Logic, Decision Making, and the Health
The study analyzed the improvement in the management of clinics and hospitals, proposed a market intelligence model for managers to use in their establishments, and measured the level of efficiency of the model and the satisfaction of managers who used the model.

The concept of market Intelligence is still little used in companies and especially in health establishments. It was clear from the results of the research questionnaires that the number of people who have already experienced the benefits of market intelligence is few, only 29% of respondents already knew the concepts and applications of Market Intelligence, 29% had already heard of it and 43% were completely unaware.

Regarding having already used some type of model for the projection of patients, only 29% reported having already used it. Another number that drew attention was that 71% of the units participating in the survey had never used demographic data, such as Population information such as gender, age, education, profession, occupation, family income level, and HDI to map the market of patients and competitors.

This study filled a gap identified in the literature regarding the absence of a Market Intelligence model that used the concepts of Market Intelligence, Data Analytics, Fuzzy Logic, Decision Making, and the health area in an integrated manner to calculate the projection of patients for chronic diseases. not transmissible, according to data from the World Health Organization (WHO), non-communicable chronic diseases are responsible for 63% of deaths in the world, and in Brazil, they are the cause of 74% of deaths.

The way it was built, the model presented satisfactory results, we can observe through the evaluation of the questionnaire that 100% of the respondents stated that the model exceeded their expectations and 100% intend to continue using the model for mergers and acquisitions projects, expansion of units, improvement of revenue, improvement of expenses/costs, and assessment for unit closures.

All five concepts studied and analyzed: Market Intelligence, Data Analytics, Fuzzy Logic, Decision Making, and the Health area have already been applied in isolation with great success, but when integrated they brought countless benefits to the management of clinics and hospitals and to the improvement of patient care, providing more security and agility in decision making by managers. The analyzed results show that the hypotheses were verified and that the proposed objectives were achieved, evidencing the contribution to knowledge.

In addition to preparing the entire mapping of patients, another benefit of the proposed model is that the establishments began to use more powerful statistical tools to
analyze the market and, with this, project market growth in an assertive way, gaining more agility in the decision making process, enabling operational managers to focus on meeting patient needs. Historically, we can see that most chronic diseases can be controlled through targeted treatment, providing a better quality of life for patients.

The research question: **Does the fuzzy logic methodology intelligence model approach help healthcare businesses predict the tendencies and better management?** was answered and the analyzed results show that the proposed objectives were achieved, evidencing the contribution to knowledge. The model was developed, and the test showed that the use of the proposed model for the projection was very close to the actual one, in addition to allowing mapping of patients, private payers, and competitors.
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