IADIS International Journal on WWW/Internet
Vol. 19, No. 1, pp. 54-70
ISSN: 1645-7641

SOCIAL INFORMATION SYSTEMS: IMPACT ON THE MORTALITY RATE OF A PUBLIC HEALTH PROGRAM

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ABSTRACT

Many recent studies have underscored the complexity of public health systems. At the same time, information systems are discussed from a strictly technological point of view to break away from a social context in which they are inseparable. Furthermore, the literature lacks research on the implementation of these systems in environments that target social innovation. To explore these relationships, this study seeks to answer the following question: What are the relationships/influences between the Social Information System, public health and social innovation? Thus, the purpose of this research is to develop an analysis model of the relationship between the studied constructs and apply it to the reality of the Neonatal Screening Program of the State of Minas Gerais (PTN-MG). To do so, the study was applied within the SUS, in the state of Minas Gerais, using the program's 15-year database. For testing the relationships between model constructs, statistical techniques of multivariate data analysis were employed. Key findings confirm that healthcare networks are configured as complex systems that require information systems with features that respect this concept. In addition, it is noted that the information system is a fundamental pillar in social innovation in health, as it has shown a significant relationship with the reduction of health problems and with the PTN-MG quality indicators. From this new tested model, others will emerge pointing to the scientific and social contribution of this research, organized in documents.

KEYWORDS

Social Information Systems, Complexity Theory, Public Health, Social Innovation

1. INTRODUCTION

Health care is described in the literature as complex adaptive systems, where there is interdependence between the actors involved promoted by interconnectivity, that is, the action of an actor can broadly influence the other connected actors (Begun et al., 2003). Consequently, a system may be considered "complex" when the interdependencies, which define it, also make it very dynamic, alternating periods of stability and chaos.

Adhering to this complexity, the principle of integrality of SUS (Brazilian Medical Care Public System) makes it necessary to aggregate actions - including health promotion, disease prevention, treatment, and rehabilitation - to allow an integration between the different areas that influence the health of the individual (Ministério da Saúde, 2018). Thus, this specific health system has multidimensional characteristics due to its interaction with other sectors of society, which has a direct or indirect impact on the health-disease process, suffering and causing transformations in the context of the ethical, ecological, epidemiological, strategic, educational, transcendental, economic, political, and psycho-socio-cultural dimensions of the health sector (Chaves, 1998).

At the same time, health care has also been the focus of research by the *Centre de Recherche sur les Innovations Sociales* (CRISES)[1] from the point of view of Social Innovation. Martinelli et al. (2003) show that social innovation, in its product and process dimensions, is characterized by at least three forms of achievement, alone or combined, carried out through some form of collective action: a) contributes to meeting human needs not considered or satisfied; b) increases access rights; c) increases human capabilities.

In the health context, social innovation is understood to be necessary to promote the development of new medicines, vaccines, and essential diagnoses, in addition to helping in public and private efforts to maintain essential services and promote health at the individual and community level (Gardner et al., 2007). As an example of this, in 2001 the Brazilian Ministry of Health - through the ordinance GM/MS No. 822 (Ministério da Saúde, 2001)- includes the National Neonatal Screening Program as a prominent public health policy for early detection of congenital diseases. This program is intended to cover 100% of live births in Brazil.

Neonatal screening is an early diagnostic strategy, which allows the detection of various diseases - metabolic, genetic and infectious - often with symptoms noticeable only through examination performed in the first days of the newborn's life. This early diagnosis research ensures medical intervention with the required urgency in children with certain diseases before the onset of irreversible sequelae (Núcleo de Ações e Pesquisa em Apoio Diagnóstico, 2018).

In Minas Gerais, the commonly known "foot test" is offered by the SUS to the entire state population through the Neonatal Screening Program (PNP-MG). The examinations and monitoring of newborns are done by the Center for Actions and Research in Diagnostic Support (Nupad), a complementary body of the Faculty of Medicine of the Public University of Minas Gerais (UFMG). Currently, nearly 6 million children have been detected by the programs and over 5,000 are being monitored (Núcleo de Ações e Pesquisa em Apoio Diagnóstico, 2018).

Given this scenario of complexity to provide social innovation, information technology (IT) should be discussed and utilized to meet the conditions of this environment. Thus, the scope of Social Information Systems (SISs) is broader, as it should support and foster the development

[1] Canadian interuniversity and multidisciplinary organization founded in 1986 and a pioneer in the studies of social innovation. It is formed by the Universities of Québec, Laval, Concordia, School of High Commercial Studies of Montreal and the National Institute of Scientific Research - Urbanization, Culture and Society.

of social and collaborative skills over time. In addition, they should facilitate the provision of services (e.g., patient in the health system) and develop social skills inherent to these systems (Kuziemsky et al., 2016).

Thus, social information systems will play an important role in transforming health systems into collaborative patient-centered systems that support care throughout the flow of care, through collaborative networks that facilitate relationships and the integration of people and processes (Kuziemsky et al., 2016). In the present case, it appears that the health information system acquires the characteristics of a social information system.

Based on this conjuncture, we intend to understand the following research problem: What are the relationships/influences between the Social Information System (Social Information System), PTN-MG (Public Health) and Health Problems? Considering this scenario, the main goal of this study is to empirically test a model that evidences the role of the social information system in the process of social innovation in the health area.

This work has five sections: the first consists of the introduction to the theme; the second discusses the methodology; in the third, the results are presented; and finally, the article presents the final discussions and recommendations for future research.

2. METHODOLOGY

The research field of this study is the state of Minas Gerais, located in the southeast of the country and with an estimated population of more than 21,000,000 inhabitants (Instituto Brasileiro de Geografia e Estatística, 2017), where we sought to focus on the Neonatal Screening Program of Minas Gerais.

The network is currently composed of approximately 4,000 basic health units, 119 hospitals, 07 Blood Collection Center, more than 20,000 health professionals, a reference center, 52 family health units and has coverage in all 853 municipalities of the State (Núcleo de Ações e Pesquisa em Apoio Diagnóstico, 2018).

2.1 Analytical Model, Hypotheses and Variables

The model proposed in this article can be classified as exploratory and, from the literature review, Figure 1 is observed that illustrates the proposed research problem: **What are the relationships/influences between the Health Information System (Social Information System), PTN-MG and health problems?**

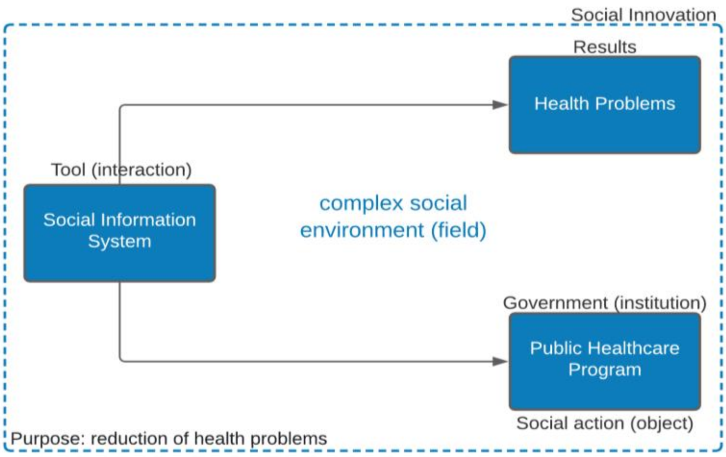

Figure 1. Model for evaluating the impact of SISs on IS and health problems
Source: Developed by the authors

Thus, it is intended to quantitatively measure the result of Social Innovation in Health (Health Problems), during the challenges of complexity (Public Health), and to investigate the role of the SIS in this relationship. The considerations examined in this model are based on the literature presented in Table 1.

Table 1. List of authors that assert the model's factors

Variable	Factors of the Social Information System	References
SIS1	Number of users or nodes of IS access (systemic and hologram principles of complexity)	Aritua et al. (2008); Bar-Yam (1997); Baranger (2000); Casti (1994); Cilliers (2000)
SIS2	The amount recorded of daily interactions (systemic and hologram principles of complexity)	Aritua et al. (2008); Bar-Yam (1997); Baranger (2000); Casti (1994); Cilliers (2000)
SIS3	Number of feedback functions (retroactive, recursive principles and autonomy/dependence on complexity)	Aritua et al. (2008); Luhmann (1999); Wiener (1950)
SIS4	Number of feedback actions observed in the IS (retroactive, recursive principles and autonomy/dependence on complexity)	Aritua et al. (2008); Luhmann (1999); Wiener (1950)
SIS5	Number of self-regulation adjustments in IS resulting from feedback actions (retroactive, recursive principles and autonomy/ dependence on complexity)	Aritua et al. (2008); Luhmann (1999); Wiener (1950)
PTN1	Percentage of test collection on the optimum date	Ministério da Saúde (2018)
PTN2	Age of newborn at first visit – hypothyroidism	
PTN3	Age of newborn at first visit – phenylketonuria	
PTN4	Age of newborn at first fibrosis consultation - cystic	
PTN5	Newborn age at first visit - sickle cell disease	
AS1	Overall death rate (mortality rate)	Grindell et al (2018); Hean et al. (2015). Nuño-Solinís (2014); Schiavo et al. (2016); Vechakul et al. (2015)
AS2	Hypothyroidism death rate (mortality rate)	
AS3	Phenylketonuria death rate (mortality rate)	
AS4	Sickle cell disease death rate (mortality rate)	
AS5	Cystic fibrosis death rate (mortality rate)	

Source: Prepared by the authors

The factors of the social information system were based on the principles of complexity theory, considering the social information system as part of a complex social system. For this, variables were thought that could indicate adherence to the principles: systemic, hologram, recursive, autonomy/dependence and retroactive.

The variables SIS3, SIS4 and SIS5 were obtained from the PTN-MG database and accounted for all the actions or feedback functions that the information system had in the period. Self-regulation was considered when the feedback action resulted in an adjustment in the PTN-MG - identified some need and generated automatic correction actions that were successful.

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Regarding the factors of the Neonatal Screening Program of the State of Minas Gerais, this study uses variables recommended by the Ministry of Health: coverage of the program, percentage of collections performed at the age considered ideal (up to the 5th day of life), the age of the newborn at the time of the first consultation (for those who presented altered tests in the screening) and the number of collection points for the test in the State. Thus, this construct does not measure the PTN-MG itself, but rather the variables considered fundamental by the Ministry of Health to evaluate the quality and efficiency of the Program.

On the other hand, the factors of Health Problems of the model are based on the metrics found in the literature, specifically for measuring the results of social innovation in health (Bazzano et al., 2017; Currie and Seddon, 2014; Grindell et al., 2018; Hean et al., 2015; Mummah et al., 2016; Nuño-Solinís, 2014; Schiavo et al., 2016; Singh, 2017; Vechakul et al. 2015). In addition, for the application of these concepts in PTN-MG, indicators were pointed out, based on the final objective of neonatal screening: "early diagnosis, in a timely manner, so that the necessary interventions allow the reduction of mortality and morbidity for congenital and hereditary diseases of the newborn" (Januário, 2015, p. 7).

The death rates used were related to children who had early outpatient follow-up in PTN-MG. Monthly accumulated rates were used since the beginning of the tests for each disease to analyze a longer period for the calculation (above 1 year). Thus, the accumulated monthly rate was calculated as follows for each of the diseases: (number of children who died/number of children under follow-up) x 100. All other variables were also calculated or accounted for month by month from January 2004 to April 2019.

Thus, this study considered program variables that could translate the impact and social transformation, in addition to clear results through the reduction of health problems in the children of the program. From the proposed model, we intend to test the following hypotheses (Figure 2):

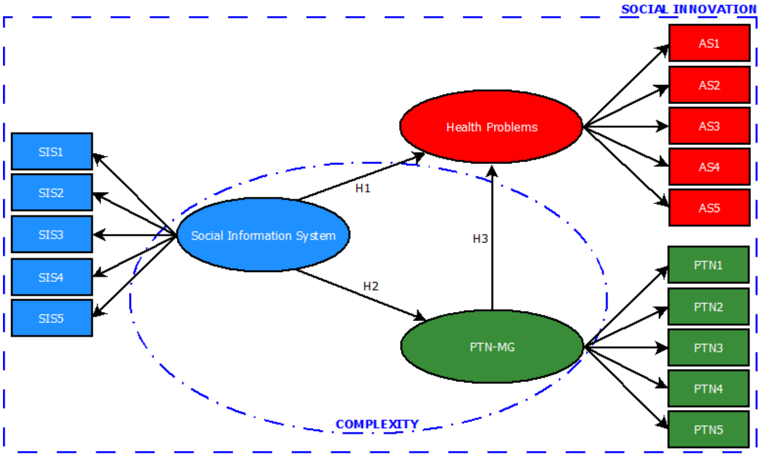

Figure 2. Hypotheses to be worked
Source: Prepared by the authors

Thus, the hypotheses are described below:

- Hypothesis 1 (H1): The social information system influences health problems.
- Hypothesis 2 (H2): The social information system influences PTN-MG.
- Hypothesis 3 (H3): The social information system and the PTN-MG influence health problems.

In the proposed model, it is observed that social innovation (territory type) comprises all constructs. This is because they present themselves as an integral part of IS. For this, this work was based on the dimensions of analysis of The SI of Cloutier (2003) that considers the following items: object (PTN-MG), field (State of Minas Gerais), target (individuals), objective (reduction of health problems), process (multisectoral and interdisciplinary) and result (health problems metrics).

In addition, the Tardif and Harrison (2005) thesaurus represented by social transformation (Table 2) are also considered:

Table 2. Social innovation concepts used

Social Transformation	Social Action	Proposal	Institution	Restriction
Reconstruction	Neonatal Screening Program (Policies and Programs)	Reduction of Health Problems (Common Good, General interest)	Government	Complexity presented by Public Health

Source: Prepared by the Author

Although the SIS is an integral part of the PTN-MG, we opted for separation to better understand its role in both the Program and health problems. In addition, it has been pointed out as one of the main characteristics of IS in health (De Rosa, 2017; Sliwa et al., 2017; Warnecke, 2017; Wass and Vimarlund, 2015). It is therefore intended to confirm this finding.

Therefore, the suggested model aims to measure relationships between constructs of the model and the possible influences exerted between them. For illustration purposes, the variables of each construct were represented by its abbreviated name and a sequence number (construct variable 01 "social information system" was named SIS1, and so on).

2.2 PTN-MG Database

The database used to verify the proposed model was analyzed from 01/2004 to 04/2019, corresponding to approximately 15 years (equivalent to approximately 3,700,000 children screened). The source of these data will be the Center for Actions and Research in Diagnostic Support of the Faculty of Medicine of UFMG (Nupad), which is the reference center of PTN-MG in the state of Minas Gerais. The database is hosted on the Microsoft SQL Server Database Manager System (DbMS).

2.3 Analysis and Interpretation of Data

The statistical study for the validation of the proposed study was done through multivariate analysis. According to Hair et al. (2009), multivariate analysis refers to all statistical techniques that simultaneously analyze multiple measurements about individuals or research objects. One of the main objectives of these techniques is to expand the exploratory ability of the researcher and to deal with the interrelationships between variables simultaneously. Specifically, for this work, two of these techniques stand out: confirmatory factor analysis and structural equation modeling.

The set available for the analyses consists of 184 observations and 18 variables, 15 referring to the development of the constructs, one referring to the month, another to the year and a unique identifier of each observation. The data cover the period from January 2004 to April 2019. In the description of the variables, measures of central tendency, position and dispersion were used.

It was verified the existence of two types of outliers: univariate, which represent divergent responses based on each of the variables of the model, and the multivariate variables, which present a different response pattern considering all variables at the same time.

The univariate outliers were diagnosed by standardizing the results, so that the mean of the variable was 0 and the standard deviation 1. Thus, univary outliers were considered those observations with standardized scores outside the range of [-3.29;3,29] (Hair et al., 2009).

Multivariate outliers were diagnosed based on Mahalanobis d^2 measurement. According to Hair, et al. (2009) this measure verifies the position of each observation compared to the center of all observations in a set of variables, and at the end, a chi-square test is performed. Individuals with a measurement significance of less than 0.001 are considered multivariate outliers.

Regarding univariate normality, the Shapiro-Wilk normality test (Shapiro and Wilk, 1965) was used. The Henze-Zirkler's test (Henze and Zirkler, 1990) was used to verify the multivariate normality of the data.

Initially, to verify the linearity of the data, Spearman correlations (Hollander and Wolfe, 1999) of the variables were analyzed alongside, since a significant correlation coefficient at the level of 5% is indicative of the existence of linearity. Additionally, the Bartlett test (Mingoti, 2005) was performed to measure linearity in each construct.

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To evaluate the relationships between the constructs, the structural equation model was used through the Partial Least Square (PLS) approach. PLS (Vinzi et al., 2010) was developed as an alternative to the traditional approach based on the covariance matrix (CBSEM), being a technique that offers greater flexibility in data modeling, since it is not necessary to satisfy some harsher assumptions such as multivariate data normality, independence between observations and high sample size.

The process of modeling, structural equations is divided into two parts: Measurement Model and Structural Model. To verify the validity of the measurement model, that is, the capacity of the set of indicators of each construct to accurately represent its respective concept, the dimensionality, reliability and convergent validity were evaluated. To verify convergent validity, the criterion proposed by Fornell and Larcker (Fornell and Larcker, 1981) was used, which indicates convergent validation when the Extracted Average Variance - AVE is greater than 50% (Henseler et al., 2009) or 40% in the case of exploratory research (Nunnally and Bernstein, 1994).

Cronbach's Alpha and Composite Reliability (Chin, 1998) were used to measure reliability. According to Tenenhaus et al. (2005) these indicators should be greater than 0.70 for an indication of construct reliability, and in exploratory research values above 0.60 are also accepted (Hair et al., 2009). For discriminant validity, the cross-loading method (Barclay et al., 1995) was used, which defines that discriminant validity is achieved when the factorial load of the item is greater than all its cross-factor loadings. To verify the dimensionality of the constructs, the Kaiser criterion (Kaiser, 1958) was used, which returns the amount of construct dimensions.

The Bootstrap method was used to calculate the confidence intervals for the weights of the measurement model and the coefficients of the structural model, providing information on the variability of the estimated parameters, thus providing the validation of the results. The Bootstrap method (Efron and Tibshirani, 1993) is widely used in inferences when the probability distribution of the variable of interest is not known.

R^2 and GoF (Tenenhaus et al., 2005) were used to evaluate the quality of the adjustments. R^2 represents on a scale of 0% to 100% how much independent constructs explain dependents, and in general, values lower than 25% represent weak explanatory capacity, values between 25% and 50% indicate moderate explanatory capacity and values above 50% show a substantial explanatory capacity (Hair et al., 2009). The GoF is a geometric mean of the AVE's of the constructs and R^2 of the model and ranges from 0% to 100%. The GoF in PLS, does not have the ability to discriminate valid models of invalids, besides not applying for models with formative constructs (Henseler and Sarstedt, 2012), only allows a synthesis of the Ave's and the R^2 of the model in a single statistic, and may be useful for future adhesion scans of different samples to the model. The software used for the development of the analyses was R (version 3.6.0).

3. RESULTS

This work made an analysis of the outliers, which are observations that present a different response pattern from the other ones. We can sort, according to Hair et al. (2009), four types of outliers: a) data tabulation errors or coding failures; b) observations arising from an extraordinary event; c) extraordinary observations for which the researcher does not have an explanation; and d) observations that are in the usual range of values for each variable but are unique in their combination of values between variables. Univariate outliers consist of divergent responses based on each of the model variables, and the multivariate ones represent a different response pattern considering all variables at the same time.

As already explained in the methodology chapter, the univariate outliers were diagnosed by standardizing the results, so that the mean of the variable was 0 and the standard deviation 1. Thus, observations with standardized scores outside the range of [-3.29; 3.29] were considered outliers (Hair et al., 2009). Based on this criterion, only 9 (0.33%) observations considered atypical in a univariate way.

Multivariate outliers were diagnosed based on Mahalanobis d^2 measurement. According to this criterion, no multivariate atypical observations were found.

However, it is believed that the observations are valid cases of the population, and their elimination could limit the generality of the multivariate analysis, although possibly improving its results (Hair et al., 2009). Thus, we chose not to exclude any of the cases.

3.1 Normality and Linearity

The Henze-Zirkler's test was used to analyze the multivariate normality of the data set. As a result, it was observed that the p-value found was less than 0.05, indicating that there is no multivariate normality. The Shapiro-Wilk test was used to verify univariate normality, and only the PTN5 variations presented normal distribution.

However, the PLS (Partial Least Square) approach (Vinzi et al., 2010) was developed as an alternative to the traditional approach based on the covariance matrix (CBSEM), being a technique that offers greater flexibility in data modeling. In it, it is not necessary to satisfy some harsher assumptions, such as multivariate data normality, independence between observations and high sample size. Thus, the lack of normality of the data is no longer a major problem when working with structural equations.

Regarding the linearity of the data, initially the correlations of the variables were analyzed evenly since a significant correlation coefficient at the level of 5% is indicative of the existence of linearity. Through spearman's correlation matrix (Hollander et al., 1999), it is observed that 88.57% of the relationships were significant at the level of 5%.

In addition, the Bartlett test (Mingoti, 2007) was performed to verify the linearity in each construct. In all constructs, p-values lower than 0.05 were observed, indicating that there is significant evidence of linearity.

3.2 Outer Model

In the analysis of the measurement model, convergent validity, discriminant validity and construct reliability were verified. Convergent validity ensures that the indicators of a construct are correlated enough to measure the latent concept. Discriminant validity verifies whether constructs effectively measure different aspects of the phenomenon of interest. Reliability reveals the consistency of measurements in measuring the concept they intend to measure.

Dimensionality, reliability, and convergent validity were verified in the analysis of the quality and validity of the constructs. To verify the convergent validity, the criterion proposed by Fornell and Larcker (1981), which indicates convergent validation when the Average Extracted Variance - AVE is greater than 50% (Henseler et al., 2009) or 40% in the case of exploratory research (Nunnaly et al., 1994). Cronbach's Alpha (A.C. and Composite Reliability C.C.) (Chin, 1998).

Table 3 presents the weights, factor loadings and commonalities of the initial measurement model. Thus, it is possible to:

- PTN3 (Age of the newborn at the first visit - phenylketonuria) presented factorial load less than 0.5 and non-significant weight indicating that this item is not important in the formation of the construct.
- PTN1 initially presented negative weight, so to facilitate the analyses, this variable was inverted, so that PTN1-I represents the percentage of test collection outside the ideal date.

Table 3. Initial measurement model

Construct	Item	Weight	I.C. - 95%¹	C.F.²	Com.³
Social Information System	SIS1	0,17	[0,15; 0,18]	0,79	0,63
	SIS2	0,22	[0,21; 0,23]	0,98	0,96
	SIS3	0,23	[0,22; 0,24]	0,98	0,96
	SIS4	0,22	[0,22; 0,23]	0,98	0,97
	SIS5	0,22	[0,21; 0,23]	0,97	0,94
Neonatal Screening Program	PTN1-I	0,51	[0,44; 0,60]	0,86	0,74
	PTN2	0,26	[0,18; 0,33]	0,69	0,48
	PTN3	0,05	[-0,07; 0,18]	0,23	0,06
	PTN4	0,20	[0,10; 0,28]	0,59	0,35
	PTN5	0,35	[0,28; 0,41]	0,71	0,51
Health Problems	AS1	0,28	[0,26; 0,30]	0,99	0,97
	AS2	0,27	[0,25; 0,29]	0,96	0,93
	AS3	0,16	[0,14; 0,18]	0,78	0,61
	AS4	0,28	[0,26; 0,30]	0,98	0,96
	AS5	0,10	[0,05; 0,15]	0,58	0,34

¹ Bootstrap Range; ² Factor loading; ³ Commonality.

Source: Prepared by the Author

Table 4 presents the weights, factor loadings and commonalities of the final measurement model, obtained after the removal of PTN3. Thus, it is possible to:

Table 4. Final measurement model

Construct	Item	Weight	I.C. - 95%[1]	C.F.[2]	Com.[3]
Social Information System	SIS1	0,17	[0,15; 0,18]	0,79	0,63
	SIS2	0,22	[0,21; 0,22]	0,98	0,96
	SIS3	0,23	[0,22; 0,24]	0,98	0,96
	SIS4	0,22	[0,22; 0,23]	0,98	0,97
	SIS5	0,22	[0,21; 0,23]	0,97	0,94
Neonatal Screening Program	PTN1-I	0,51	[0,44; 0,61]	0,86	0,75
	PTN2	0,27	[0,18; 0,34]	0,69	0,48
	PTN4	0,20	[0,11; 0,28]	0,60	0,36
	PTN5	0,35	[0,29; 0,42]	0,71	0,50
Health Problems	AS1	0,28	[0,26; 0,30]	0,99	0,97
	AS2	0,27	[0,25; 0,29]	0,96	0,93
	AS3	0,16	[0,14; 0,18]	0,78	0,61
	AS4	0,28	[0,26; 0,30]	0,98	0,96
	AS5	0,10	[0,05; 0,15]	0,58	0,34

[1]Bootstrap Range; [2] Factor loading; [3] Commonality.

Source: Prepared by the Author

Table 5 presents the analysis of convergent validity, dimensionality, and reliability of the constructs of the measurement model. Thus, it is possible to:

- In all constructs, reliability indices C.A. and C.R. were higher than 0.60, thus evidencing their reliability.
- According to the Kaiser criterion, all constructs were one-dimensional.
- The AVE's of all constructs were higher than 0.40, thus evidencing the convergent validation of the same.

Table 5. Validation of measurement model

Constructs	Item	C.A.[1]	C.R.[2]	Dim. [3]	AVE[4]
Social Information System	5	0,97	0,98	1	0,89
Newborn Screening Program	4	0,70	0,82	1	0,52
Health problems	5	0,92	0,94	1	0,76

[1] Cronbach Alfa, [2] Composite Reliability, [3] Dimensionality, [4] Extracted Variance.

Source: Prepared by the Author

Table 6 presents the discriminant validation by the method of crossed factorial loads (Barclay et al., 1995). It is observed that there was discriminant validation in all constructs since the factorial loads of the items were higher than their respective crossed factorial loads.

Table 6. Discriminant validation by the method of crossed factorial loads

Construct	Item	Social Information System	Neonatal Screening Program	Health Problems
Social Information System	SIS1	0,79	-0,40	-0,67
	SIS2	0,98	-0,53	-0,88
	SIS3	0,98	-0,60	-0,91
	SIS4	0,98	-0,57	-0,86
	SIS5	0,97	-0,57	-0,86
Neonatal Screening Program	PTN1-I	-0,55	0,86	0,69
	PTN2	-0,29	0,69	0,35
	PTN4	-0,25	0,60	0,25
	PTN5	-0,44	0,71	0,41
Health Problems	AS1	-0,93	0,68	0,99
	AS2	-0,88	0,66	0,96
	AS3	-0,57	0,35	0,78
	AS4	-0,92	0,71	0,98
	AS5	-0,42	0,17	0,58

Source: Prepared by the Author

Thus, it is evident that all three constructs are uniquely different from the others.

3.3 Inner Model

The measurement and regression models were performed using the PLS method. This has been referred to as a soft modeling technique with minimal demand, when considering the scales of measurements, sample size and residual distributions (Monecke and Leisch, 2012).

Table 7 presents the structural model. Thus, it is possible to:

- There was a significant influence (p-value=0.00) and negative (β= - 0.57 [-0.64;-0.51]) of social information system on the Neonatal Screening Program, so the higher the Social Information System, the smaller the indicator of Neonatal Screening Program will tend to be.
- There was a significant influence (p-value=0.00) and negative (β= - 0.77 [-0.82;-0.71]) of social information system on health problems, so the higher the Social Information System, the smaller health problems will tend to be.
- There was a significant influence (p-value=0.00) and positive (β=0.20 [0.15;0.27]) of the Neonatal Screening Program on Health Problems, so the higher the Neonatal Screening Program, the greater the health problems will tend to be.
- The Construct of Social Information System was able to explain 32.23% of the variability of the Neonatal Screening Program and both were able to explain 82.08% of the variability of Health Problems. In addition, it is worth mentioning that the model presented a GoF of 65.01%.

Table 7. Structural Model

Endogenous	Exogenous	β	E.P. (β)[1]	I.C. - 95%[2]	Valor-p	R^2
Neonatal Newborn Screening Program	Social Information System	-0,57	0,06	[-0,64; -0,51]	0,00	32,23%
Health Problem	Social Information System	-0,77	0,04	[-0,82; -0,71]	0,00	82,08%
	Neonatal Screening Program	0,20	0,04	[0,15; 0,27]	0,00	

[1] Standard Error; [2] Bootstrap range; GoF = 65.01%.

Source: Prepared by the Author

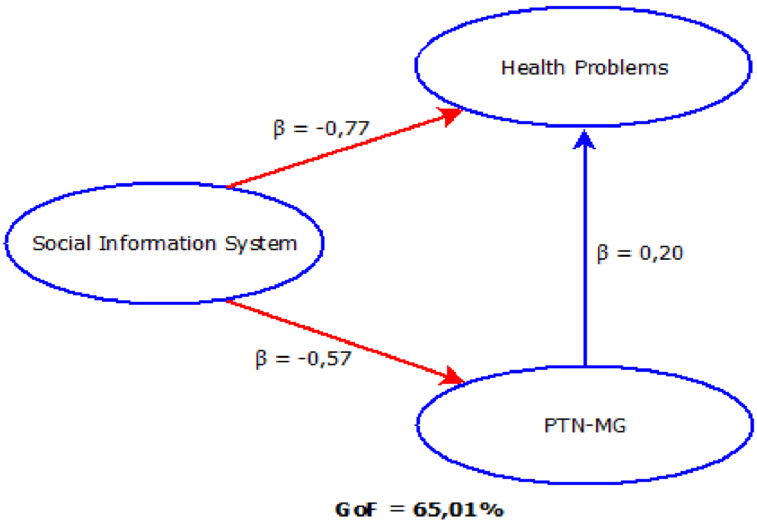

Figure 3. Structural Model Illustration
Source: Prepared by the Author

It is important to point out that the value β shows the strength of relationships. This means that the closer to 1, the greater the influence. The Social Information System had a β = -0.77 on health problems and was the largest β the model. Thus, it represents an influence 3.85 times greater than the indicators of PTN-MG (β = 0.20) on health problems.

Thus, of the 82.08% observed in R2 of the model, it can be affirmed that the Social Information System represents approximately 65.16% of the total variability of health problems. PTN-MG represents 16.92% since it has a 3.85 times lower influence.

4. CONCLUSION

Recently, several studies on social innovation have been carried out, however, the literature shows the complexity about this concept (Edwards-Schachter and Wallace, 2015). There are difficulties in the elaboration of indicators that allow to explain empirical phenomena related to the theme (Castro-Spila and Unceta, 2015; Unceta et al., 2016).

It is in this context that the model proposed in this study tries to explain the influence of the information system in a large public health program and, specifically, in the results that this program as a social innovation must achieve.

The results show that PTN-MG is a public health program that is configured as a social innovation, as it managed to solve the problems it proposes, that is, it reduced the mortality rate of the patients involved. The model showed that the reduction in the program's indicators has a significant relationship with the reduction of health problems over 15 years. In addition, considering that the SISO is part of the PTN-MG, 82% of the reduction observed in health problems can be explained by the program.

It is also noticed that the indicators recommended by the Ministry of Health to assess the quality of programs in the country may be insufficient. This is due to the strength of the indicators' relationship to health problems below the strength observed by the information system (3.5 times less). It is concluded, therefore, that the management of the program is a primary factor to be considered by federal policies regarding neonatal screening. The indicators pointed out by the government represent only part of the measurement.

Another important detail was the significant and negative relationship of the information system with both PTN-MG and health problems, that is, the higher the SISO, the lower the indicators and mortality. This is a valuable contribution, given the weight observed in the relationships between the constructs, as it reinforces that the complex characteristics must be considered when implementing a SISO.

Therefore, as a contribution, it can be emphasized that the results indicate that some factors must be considered in the planning and implementation of health information systems. These data are important so that initiatives, especially social innovation, can have indicators or clear metrics to demonstrate their effectiveness, especially in public policy actions.

As work limitations, it is understood that this study had its research carried out based on a specific health information system in operation in a Brazilian state. As a proposal for future research, the following can be indicated: application of the model in other realities and in other information systems to confirm the relationships identified.

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