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RESEARCH ARTICLE

A generic sustainable performance management system for hospital supply chain: design & analysis

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ABSTRACT
The assessment of the hospital supply chain management represents a key challenge by virtue of the complexity of the healthcare sector. The purpose of this study is to introduce a hybrid approach that helps hospital administrators to clearly identify, evaluate, and narrow the key performance criteria for their supply chain. The methodology attempts to minimise information loss, reduce the fuzziness and subjectivity of the collected data and describes the interdependence among criteria. The proposed generic framework can be valuable for hospitals organisations aiming for a sustainable performance decision-making process. The combination of the Fuzzy Delphi method and Structural Equation Modelling proved to be effective in determining the pillars driving the sustainable performance of the hospital supply chain.

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Performance; hospital; healthcare; sustainability; fuzzy delphi method; structural equation modelling

1. Introduction

In today's growing competition in the healthcare industry, hospital managers are stressing the importance of an effective supply chain as it has a crucial role in patient's well-being, reducing costs, and improving the organisation's performance (Schneller & Smeltzer, 2006). The highly competitive sector is pressuring hospitals to develop dynamic capabilities in order to provide high-quality products and services that are coherent with the rapidly changing and complex environment (Teece, 2009). Thus, while maintaining the safety of all stakeholders and service quality, hospitals turned to delivery cost reduction and process integration to gain a competitive edge in the market.

The escalated demand of integration extended the Supply Chain Management (SCM) scope in the healthcare industry. SCM has drawn substantial attention since it showed a significant impact on hospital performance. Delivering the right product, at the right time, with the right quantity helps preventing medical errors, reducing waste, and improving quality of care products and services (Byrnes, 2004; Kowalski, 2009). Simultaneously with the increased demand on strong economic performance of these supply chains, organisations are now held also responsible for their environmental and social performances.

The pressures derived from internal and external parties including governmental and non-governmental organisations, internal stakeholders, and socially aware communities resulted in sustainability as a trending topic in the literature. The concept urges hospitals to reach a certain level of maturity in management system integration and address their responsibility towards their stakeholders and the environment (Poltronieri et al., 2019). It also enables hospitals to integrate environmental and social issues into their corporate strategies (Srivastava, 2007). Therefore, it is impossible to do so without incorporating Sustainable Supply Chain Management (SSCM) (Preuss, 2005).

There have been many attempts from different perspectives at defining SSCM in the literature (Tajbakhsh & Hassini, 2015), but for our study we chose a holistic definition of SSCM as the management of physical information and financial flows as well as cooperation among all supply chain stakeholders (suppliers, customers, etc.) while taking into consideration objectives from all three perspectives of sustainable development, i.e., economic, social, and environmental (Seuring & Müller, 2008). With the involvement of various perspectives, it is contended that it is impossible to group all dimensions to a single unity of measure in SSCM. According to Gunasekaran et al., (2004) many organisations are struggling with optimising their supply chain because they are not adopting the correct performance measures to fully integrate their supply chain life cycle processes. Pai et al., (2019) went even further and stated that performance struggles can lead to hospitals closures.

Therefore, a multiphase qualitative study was undertaken to develop a generic Sustainable Performance Management System (SPMS). The scope of the study will define first, on a macro level, the hospital policy and system decision making process. The scope also includes the identification of standard performance criterions of each aspect of

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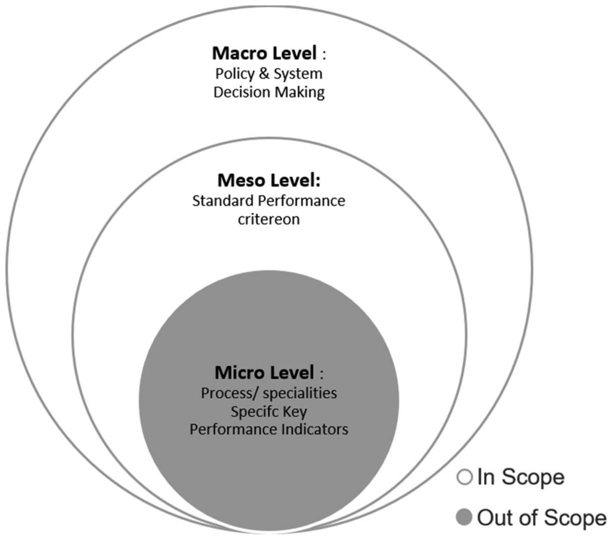


Figure 1. Research scope.

hospital performance on a meso level. Specific processes/specialties Key Performance indicators (KPIs) are out of scope as described in Figure 1.

The first phase of our qualitative approach includes a review of the existent hospital performance scientific state of the art. By applying Fuzzy Delphi Method (FDM) and consulting experts of academia and industries, the performance evaluations factors are identified, ranked and the best criteria are selected to measure the SSCM performance. Second, the chosen performance measurements are grouped into pillars. Structural Equation Modelling (SEM) is employed to assess the strength of the hypothesised links and validate the proposed integrated performance framework. The remainder of the paper is as follows: Section 2 discusses the background literature of healthcare performance leading to the research gap motivating this study. Section 3 presents the methodology of the study and finally the results of the developed performance management system are discussed in Section 4.

2. Literature review

Performance Management System (PMS) is the process of assessing the organisation progress throughout financial and non-financial measures in achieving the strategic goals and objectives throughout the classical three categories Structure, Process and Outcome (Donabedian, 1980).

Several PMSs have been proposed over the years for the healthcare industry. Nabitz et al. (2000) presented the hospitals' experiences with the European Foundation for Quality Management approach. The next nine criteria: leadership, people, policy & strategy, partnership & resources, processes, people results, customer results, society results and key performance results were suggested by the authors to measure the hospitals performance. A Porter-SCOR modelling approach was adopted by Di Martinelly et al. (2009) for the hospital supply chain where the author used the Supply Chain Operations Reference (SCOR) model KPIs to measure the performance of the process-oriented hospital supply chain.

The Balanced ScoreCard (BSC) suitability to the non-profit and healthcare organisations is discussed by both Kaplan, (2001) Kollberg & Elg, (2011). The authors emphasised that non-profit organisation rearranged the geography of their BSC placing the customer perspective as primary objective instead of the financial perspective. Purbey et al. (2007) identified in his review multiple performance measurement criterions and developed a new framework for measuring performance of healthcare processes. Moons et al. (2019) provided a literature study for measuring the logistics performance of internal hospital supply chains in terms of quality, time, finance, and productivity.

In recent years an entire stream of literature emerged defining hospital supply chain performance management as a Multi-Criteria Decision Making (MCDM) problem. Several fuzzy MCDM tools have been deployed to choose the optimal solutions for this topic. Dey et al., (2008) initially combined Analytic Hierarchy Process (AHP) and logical framework to present a performance management system for healthcare services. Afterwards, the proposed framework is implemented in the intensive care units comparing the performance of three different hospitals in developing nations. Using also AHP, Hariharan et al. (2004) identified patient care, establishment, and administration as the most important sections whose processes could be measured.

Chan (2006) discussed how Canadian hospitals have already implemented the Balanced Scorecard to measure their performance and followed the AHP methodology to compare between hospitals performance using the already established BSC measurement. Fuzzy MCDM methods were applied also to evaluate the service quality of some Turkish hospitals. Both Ahsan & Bartlema, (2004) and Tsai et al. (2010) used in their study the Delphi method followed by Fuzzy AHP in order to develop a performance management system for healthcare organisations and compare hospitals performance. Basing their study on the existing key performance indicators in the literature, Akdag et al. (2014) used AHP, Fuzzy Numbers, and TOPSIS methods to measure and rank the performance of 4 Turkish hospitals. Tyagi and Singh (2017) evaluated the hospital performance management using the multi-criteria futuristic fuzzy decision hierarchy and generated different scenarios and action plan to enhance the hospital performance.

Structural Equation Modelling was also deployed in many articles discussing the healthcare supply chain performance problem. Jakhar and Barua (2014) proposed an integrated model of supply chain performance evaluation and decision-making to help hospital administrators gauge their organisation's performance and guide them through their decision-making process. The model was developed with a combined methodology of SEM and Fuzzy AHP resulting in five important performance evaluation criteria along with a total of 19 sub-criteria.

Lee et al. (2011) examined the impact of supply chain innovation on healthcare organisation's performance. The authors developed and tested a structural equation model describing the positive influence of supply chain innovation, supplier cooperation, supply chain efficiency, and quality management practices on hospital performance. An empirical test was conducted in Chen et al., (2013) leading the authors to identify trust, knowledge exchange, IT integration as key factors that impact hospital supply chain performance. Both Aragon and Gesell (2003) and Sahin et al. (2007) used the same technique to focus on patient satisfaction. The two studies showed that patient satisfaction is influenced by different factors like the level of education, physician & nursing services and waiting times.

Unlike traditional performance measures which concentrate only on the economic part of the organisation, the implementation of a SPMS helps hospitals explore the impact also of the different stakeholders and social sustainability on their supply chain performance. SPMS will also allow the organisation to measure their environmental performance and proceed better in its future policies and decisions. In addition to customer satisfaction, internal business processes, quality of service or products, continuous improvement efforts and financial performance, public responsibility and social commitment are integrated into the performance management system to gauge not only the basic performance categories but also to measure the social dimension of sustainability of a private clinic (Curtright et al., 2000).

Hossain and Thakur (2021) focused on the environmental dimension of the healthcare SCM. The authors prioritised drivers of healthcare by-product management system, coordinating and facilitating green suppliers and green packaging of pharmaceutical as well as other essential items. Nagariya et al. (2021) evaluate the case hospital based on six barriers which are reduction in solid waste, compliance with applicable environmental laws and regulations, water usage efficiency, training and education of employees, return on investment, and safety equipment for employees.

Finally, Pederneiras et al. (2021) suggested a hybrid data envelopment analysis approach to study hospital sustainability in Portugal under environmental, social, and economic perspectives. The authors proposed 16 indicators based on the classical triple bottom line approach to compare the following hospitals' dimension: Procurement and consumption of resources, Waste of resources, Hospital infection, Quality of and access to healthcare services, Community well-being and Cost of services.

As presented in this section, there have been many articles over the years for hospital supply chain performance measurement problem. The majority of the studies emphasised only one or two of these dimensions to investigate hospitals performance. For the minority of articles with the triple bottom line approach, the focus was only on specific metrics and processes of the supply chain. No interdependencies between the identified performance barriers were investigated for a better performance decision-making process. To the best of our knowledge, we have not found any studies that developed a structured generic framework for the supply chain performance evaluation that englobes all together and analyzes the direct and indirect interrelationships of performance criterions in terms of the three dimensions of sustainability: economic, social, and environmental.

3. Methodology

First step of our research protocol was to check the existence of holistic literature reviews. Also, we carried out our own literature review research on Science Direct, SCOPUS and Google Scholar using different combinations of the following keywords: healthcare, hospital, performance, sustainability and supply chain management. We limited our review to English written articles that have been published in the past two decades.

The review of the literature related to performance management in healthcare sector helped identify the research gap and define the study objective. The next phase is to develop and test a sustainable performance management system for hospitals.

A three-step Fuzzy Delphi protocol was applied in the first phase to reach our goal: i) Questionnaire design, ii) Face-to-Face meetings, and iii) Focus group discussion. we started initially by developing a structured questionnaire based on the literature review. All healthcare performance evaluations criteria identified shaped the basis of the survey. The survey will involve a varying panel, between three and fifteen, of experts composed of healthcare sector's professionals and academicians (Manoliadis et al., 2006). We employed a 7-point Likert scale for all questionnaire items reflecting the wording which varies from extremely unimportant to extremely important indicating their level of importance in hospitals' performance.

During simple Face-to-Face meeting, the data will be collected and will represent the inputs for the Fuzzy Delphi Method application. Following the FDM results, the chosen performance measurements will be categorised into pillars shaping the basis for our generic sustainable framework. Subsequently, the results with the suggested pillars will be presented by the researcher to the panel during an organised workshop. A focus group discussion with the experts will be held to determine the interrelationships (direct & indirect) to formalise the model hypotheses.

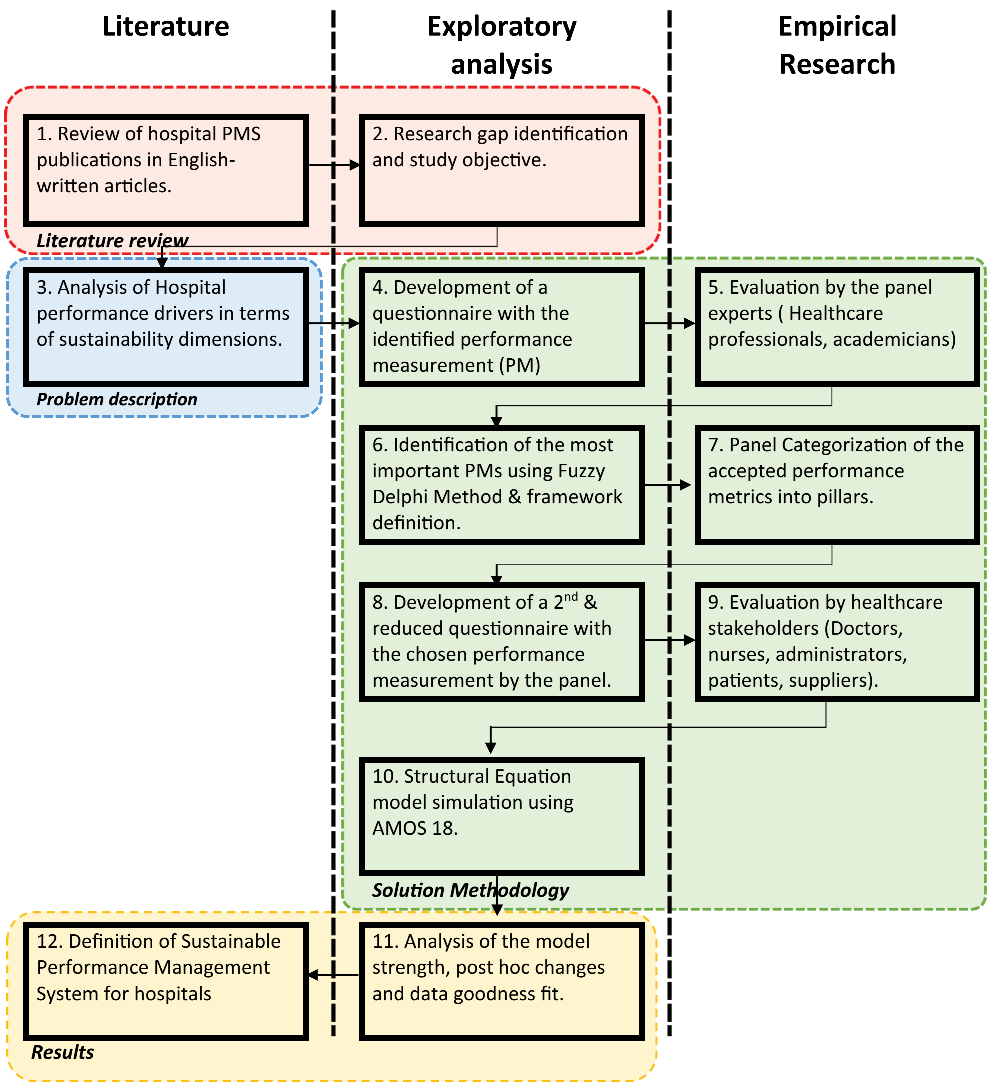
The second phase consisted in testing the framework applicability to the healthcare sector. An empirical research with an enhanced survey, containing only the selected criterions, is then conducted with a larger healthcare population to collect data. Afterwards, Structural Equation Modelling techniques are considered to validate the interdependence among the performance measures. The detailed research methodology is described in Table 1.

3.1. Fuzzy delphi method

It's well known that the traditional Delphi method developed by Dalkey and Helmer (1963) has always suffered from some imperfections like low convergence of expert opinions, long progress of investigation, and the possibility of filtering out or influencing some expert opinions causing the loss of critical information (Kuo & Chen, 2008). Therefore, Murry et al. (1985) suggested the concept of integrating Fuzzy set theory into the traditional Delphi technique to overcome these weaknesses. Ishikawa et al. (1993) introduced the max-min Delphi method and fuzzy integration Delphi method to predict the prevalence of computers in the future. Unfortunately, the proposed methods are limited to time series data prediction.

Furthermore, Hsu and Yang (2000) used the Triangular Fuzzy Numbers (TFN) to embody the expert's opinions and create the Fuzzy Delphi Method. The concept of this adopted method is straightforward. It is designed to collect group decision and transform linguistics preferences into TFNs. The max and min values of the panel's opinions represent the two extremity points of triangular fuzzy numbers, and the geometric mean is adopted as the

Table 1. The combined FDM & SEM methodology.



membership degree to provide the statistically unbiased outcome of an objective evaluation and avoid the impact of extreme values. FDM steps are the following:

(1) Panel's decision collection: collect the score of each evaluation factor provided by each expert using the defined scale.

(2) Triangular Fuzzy Numbers set up: the goal of this step is to calculate the TFN value of each factor given by every expert. Considering the evaluation value (weight) of no. j factor given by No i expert is $\tilde{w}_{ij} = (l_{ij}, m_{ij}, u_{ij})$, i = 1, 2 . . . n & j = 1, 2 . . . m. Then fuzzy weighting $\tilde{w}$ of j element is $\tilde{w}_j = (l_j, m_j, u_j)$, j = 1, 2 . . . m among which:

$$l_j = \mathrm{Min}\{l_{ij}\} \tag{1}$$

$$m_j = \sqrt[n]{\prod_{1}^{n} m_{ij}} \tag{2}$$

$$u_j = \mathrm{Max}\{u_{ij}\} \tag{3}$$

(1) De-fuzzification: Center of gravity method is used to de-fuzzify the weight w_j of every factor to definite value S_j as follows:

$$P_j = \frac{l_j + m_j + u_j}{3}, j = 1, 2 \ldots m. \tag{4}$$

(2) Evaluation indexes filtering: in this final step, best ranked factors can be chosen by setting the threshold. If$P_j > \alpha$, then No. j factor is accepted as an evaluation factor, other ways if$P_j < \alpha$ then eliminate no. j factor.

To sum up, FDM advantages lie in achieving the consensus of the panel while integrating every expert opinion and reducing the subjective and the fuzzy parts of the human reasoning. Moreover, FDM outcome improved the efficiency and quality of the questionnaire by eliminating the non-important performance measurement. The selected performance factors will represent the core variables for our structural equation model. The improved survey will be the main tool to collect additional data in order to test the interdependence between performance factors (variables) and confirm its influence on the SSCM performance.

3.2. *Structural equation modeling*

Structural equation modeling is a statistical approach that combines between both quantitative as well as qualitative data in order to test and quantify causal relationships (Hair et al. 1998). As a result of it broad and flexible framework of multiple related methods, SEM enables researchers to analyze the links and directionality of each construct through two models: The measurement model and the structural model (see Figure 2). SEM takes also measurement error in consideration while analyzing the data statistically (Raykov & Marcoulides 2006).

The measurement model examines the linear regression and describes the way in which observed, measured variables X are related to latent unmeasured variables ξ via Confirmatory Factor Analysis (CFA). Major elements of the measurement model are the reliability and validity tests. Reliability refers to the consistency of a measure and will be evaluated based on Cronbach's α-value and construct reliability. It represents the variance of measurement values and non-systematic errors resulting from reproducing the same measurement of the same concept under the same conditions. Validity evaluates the accuracy of a measure and provides the degree to which the measurements actually describe the variable they are intended to.

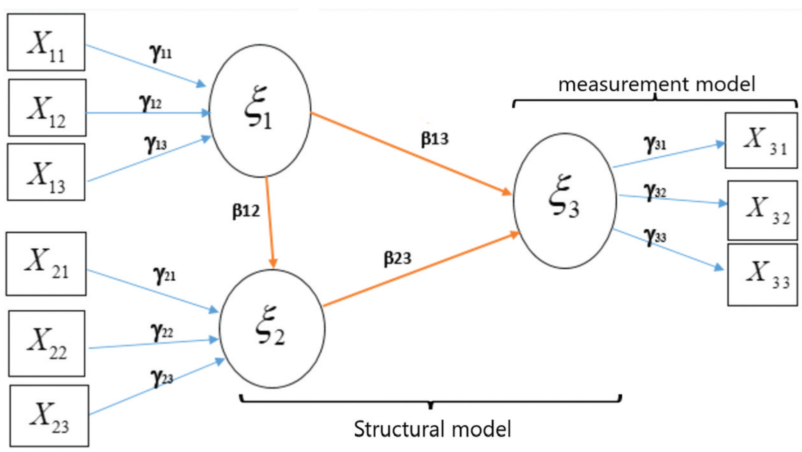


Figure 2. Example of a structural equation model.

Average Variance Extracted (AVE) is applied to determine the convergent validity of theoretical constructs.

The structural model assesses the strength of the hypothesised links between the latent variables. Path Analysis (PA) is applied to evaluate the regression coefficients between latent variables. In other words, PA examines the weights of each path representing the impact of one latent construct on another (MacCallum & Austin, 2000). The goodness of fit model is also revealed. Schumacker and Lomax (2016) state that there's no single test of significance which can absolutely indicate fitness of a model to a data sample. Hence, the matching of the data to a developed model is measured by multiples fit indices such as Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Tucker Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA).

The determination of the proper sample size N in SEM is a crucial issue. Despite the criticality of this variable, there is still no universal or correct calculation method for determining the appropriate size. Evidence showed that simple structural equation models can be tested even by small simple sizes, but usually the minimum to consider for conducting a SEM is N = 100 (Ding et al., 1995).

For normally distributed data, simulation studies demonstrated that N = 150 is enough to run a model with no missing data, other researchers advised even a bigger sample size of N = 200 (Boomsma & Hoogland, 2001). Statistics scholars suggested to proceed with the ratio of observations to estimated parameters (N:q). According to Kline (2015), the ratio should be 20 to 1, while Schreiber et al. (2006) proposed a ratio of 10 to 1 or even lower 5 to 1 as discussed in Bentler & Chou, (1987). Evidently, no consensus has been reached for SEM simple size definition as there is a lot of variance and uncertainty surrounding this topic.

4. Results & discussions

4.1. Empirical setting

The reviewed evaluation factors, which represent multiple healthcare stakeholders, were all listed in the first survey for seven experts who expressed their full commitment to the study in order to collect their expert opinions. The selected panel is a group of four supply chain healthcare professionals and three academicians practicing in the universities and hospitals of the Northern region of Morocco.

During the Face-to-Face meetings, each expert was briefed about the research objective. Ambiguities were also clarified for a better understanding of the criteria that were evaluated based on the Fuzzy numbers 7-Likert scale showed in Table 2.

Table 2. FDM triangular Fuzzy numbers definition.

Fuzzy number	Definition
$\tilde{1} = (1, 1, 1)$	Extremely Not important
$\tilde{2} = (1, 2, 3)$	Very Not important
$\tilde{3} = (2, 3, 4)$	Slightly Not important
$\tilde{4} = (3, 4, 5)$	Important
$\tilde{5} = (4, 5, 6)$	Slightly very Important
$\tilde{6} = (5, 6, 7)$	Very important
$\tilde{7} = (6, 7, 7)$	Extremely important

Next step is the collection of the FDM questionnaires. The collected ratings of each expert are converted to the corresponding triangular fuzzy number and FDM is applied to calculate the defuzzified results. The Threshold 4 indicates that the criterion is important in hospital performance. Hence, for our study the performance measurements above this threshold are to consider in our SPMS while criteria with threshold below 4 are excluded. Table 3 lists the FDM results mentioning both the accepted and rejected evaluations factors with their corresponding values.

The accepted evaluations factors were grouped by the researcher into the following five categories as shown in Figure 3.

- Strategic Planning (SP):
  a. Policy & Strategy (SP.1): Category of KPIs defined to evaluate the organisation's strategy, the respect of standards and alignment with the defined missions.
  b. Leadership (SP.2): The goal is to have the feedback and measure management involvement, recognition, organisation's culture and communication within the establishment.
- Development & Social Sustainability (D&SS):
  a. Safety & Risk Management (D&SS.1): set of performance indicators like Number of accidents, medical errors, lost time to injuries, number of resolved safety tags, etc. dedicated to reflecting the safety & risk management status within the organisation.
  b. Learning & Growth (D&SS.2): in order to reach operational excellence, KPIs should describe the value provided from and to stakeholders (employees, suppliers, BPs...) e.g., training completion rate, job role Competency Rate, Number of Kaizens/improvements proposals implemented.
  c. Public & Stakeholder Responsibility (D&SS.3): Set of indicators dedicated to measure stakeholder satisfaction, number of voluntary work and social activities, number of stakeholder compliance issues, audit completion rate, etc.
- Green Process Management (GPM)

Table 3. FDM results.

ID	Criterion	TFN	Pj	Status	References
CSR.1	Customer Satisfaction	(6; 6.55; 7)	6.52	Accepted	Purbey et al. (2007); Kaplan (2001); Kollberg and Elg (2011); Chan (2006); Jakhar and Barua (2014); Aragon and Gesell (2003); Curtright et al. (2000)
D&SS.1	Risk & Safety Management	(5; 5.95; 7)	5.98	Accepted	Purbey et al. (2007); Moons et al. (2019); Tyagi and Singh (2017)
GPM.2	Effectiveness (Productivity)	(5; 5.82; 7)	5.94	Accepted	Di Martinelly et al. (2009); Purbey et al. (2007); Moons et al. (2019); Tyagi and Singh (2017); Jakhar and Barua (2014); Curtright et al. (2000)
SP.1	Policy & Strategy	(4; 5.71; 7)	5.57	Accepted	Nabitz et al. (2000)
GPM.1	Efficiency	(5; 5.55; 6)	5.52	Accepted	Purbey et al. (2007); Tyagi and Singh (2017); Lee et al. (2011); Curtright et al. (2000)
SP.2	Leadership	(4; 5.24; 6)	5.08	Accepted	Nabitz et al. (2000)
D&SS.2	Learning and Growth	(4; 5.07; 6)	5.02	Accepted	Purbey et al. (2007); Kaplan (2001)
D&SS.3	Public & Stakeholder Responsibility	(4; 4.94; 6)	4.98	Accepted	Tyagi and Singh (2017)
CSR.2	Market &Competitiveness	(4; 4.81; 6)	4.94	Accepted	Kaplan (2001)
GPM.3	Agility (Flexibility)	(4; 4.66; 6)	4.89	Accepted	Di Martinelly et al. (2009); Purbey et al. (2007); Jakhar and Barua (2014)
BR.2	Costs	(4; 4.52; 6)	4.84	Accepted	Di Martinelly et al. (2009); Moons et al. (2019); Chan (2006) Pederneiras et al. (2021)
BR.3	Business Growth & Revenue	(5; 4.4; 5)	4.80	Accepted	Kaplan (2001); Kollberg and Elg (2011)
BR.1	Asset management	(4; 4.4; 5)	4.47	Accepted	Di Martinelly et al. (2009)
GPM.4	Environmental sustainability	(4; 4.26; 5)	4.42	Accepted	Nagariya et al, (2021); Pederneiras et al. (2021)
-	Community building	(1; 3.36; 5)	3.12	Rejected	Kaplan (2001); Kollberg and Elg (2011)
-	Cycle Time	(1; 3.22; 5)	3.07	Rejected	Moons et al. (2019); Jakhar and Barua (2014)
-	Innovation	(1; 2.84; 5)	2.95	Rejected	Kaplan (2001); Kollberg and Elg (2011); Lee et al. (2011)
-	Partnerships & Resources	(1; 2.84; 5)	2.95	Rejected	Nabitz et al. (2000)
-	Supplier cooperation	(1; 2.32; 5)	2.77	Rejected	Lee et al. (2011)
-	Staff orientation	(1; 2.28; 5)	2.76	Rejected	Tyagi and Singh (2017)
-	Social commitment	(1; 3.02; 4)	2.67	Rejected	Curtright et al. (2000)
-	internal stability	(1; 1.87; 5)	2.62	Rejected	Kaplan (2001)

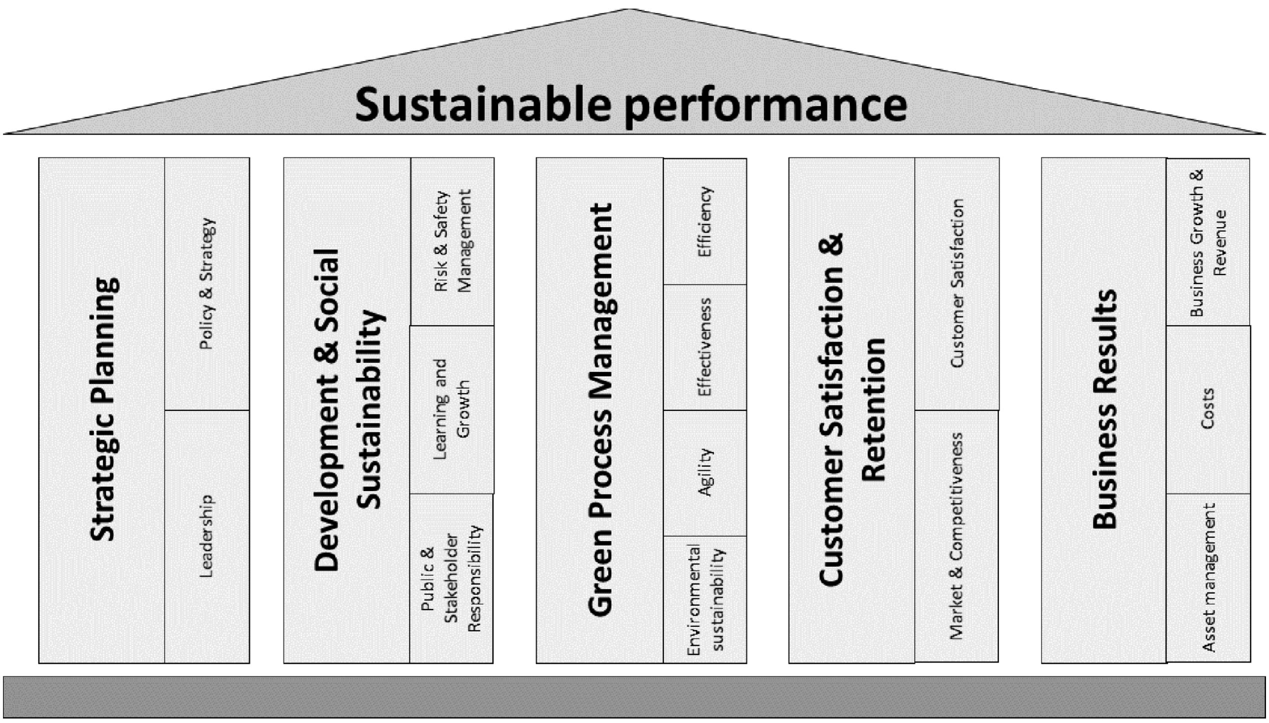


Figure 3. The proposed pillars for the sustainable performance management system.

a. Effectiveness (GPM.1): Sets of indicators that measure the effectiveness of the processes and shows if the organisation is on the right path to reach the end results (result oriented).
b. Efficiency (GPM.2): Sets of indicators to measure the ability to perform tasks as expected on time, the right quantity, the right quality (yield oriented).
c. Agility (GPM.3): A number of KPIs set to evaluate the organisation ability to respond to external influences (e.g., Order/Patient flow increase/decrease).
d. Waste & Environmental Sustainability (GPM.4): set of performance indicators to measure the organisation environmental impact (Water, energy, etc) & its waste.

- Customer Satisfaction and Retention (CSR)
  a. Customer Satisfaction (CSR.1): This group of indicators is customer focused; it will reflect the customer satisfaction upon organisation services and products.
  b. Market & Competitiveness (CSR.2): theses performance indicators help determine the organisation whether it gained, retained and/or lost new customer & markets.
- Business Results (BR).
  a. Business Growth & Revenue (BR.1): Key performance indicators defined to measure the valuation and profitability of the establishment
  b. Costs (BR.2): Sets of indicators that are measuring the cost of operating the supply chain (Labour, materiel, transport, etc.)
  c. Asset management (BR.3): This criterion's KPIs are set to evaluate the cash-to-cash cycle time & working capital.

Once the categories were identified and formed the measurement model, The framework was then designed as a structural equation model to validate its generic applicability to hospital supply chain. The question to answer is: "What are the pillars that have direct impact on others?". The panel consensus was reached during the focus group discussion where the outcome was the following hypotheses:

- H1: Strategic Planning has a positive direct impact on Development & Social Sustainability.
- H2: Strategic Planning has a positive direct impact on Green Process Management.
- H3: Development & Social Sustainability has a positive direct impact on Green Process Management.
- H4: Green Process Management has a positive direct impact on Customer Satisfaction and Retention.
- H5: Green Process Management has a positive direct impact on Business Results.
- H6: Customer Satisfaction and Retention has a positive direct impact on Business Results.

4.2. Data collection

Next a field survey approach was put in place to test the research hypotheses in a bigger scale. The 14 accepted criteria formed a second questionnaire which was used to explore the respondents' perceptions of healthcare SSCM performance. The survey instrument also contained questions regarding the respondent's role which varies from Shareholder, Stakeholder (suppliers, physicians, nurses, etc.), SCM administrator and patient. Along the role, the instrument specifies if the respondents are working or choosing for treatment the private or the public healthcare sector.

Prior to the implementation of the questionnaire, a pilot test was conducted on a small group of participants to evaluate the understanding of the items. The 10 chosen participants all confirmed the comprehensibility of the items and took approximately 5 minutes to complete the survey. The items of the second survey were scored also based on a 7-point Likert scale. 500 questionnaires were distributed in both private clinics and public hospitals of the city of Tangier located in the northern region of Morocco. In addition, electronic format of the survey was sent by email and posted also on healthcare communities in social networks (Facebook, LinkedIn) to reinforce and diversify the data collection process. Initial sample consisted of 347 respondents, but 19 questionnaires were rejected due to incomplete information. Tables 4 sums up the characteristics of the final sample.

4.3. Data analysis

We begin by selecting first the software and estimation parameter for data analysis phase. A variety of software (LISREL, Smart PLS and Lavaan) exist but for our study we proceeded with Analysis of Moment Structures (AMOS) 18 for its user-friendly interfaces and powerful graphics. As for the estimation parameter, maximum likelihood parameter estimation was utilised to ensure the normality of data distribution (Kline, 2015). The method proved to be effective with minimum variance and unbiasedness (Raykov & Marcoulides, 2000).

Confirmatory Factor Analysis is performed to test how well the latent variables are represented by the measured variables, afterwards the reliability and the validity of the measurement model are evaluated. We examined the reliability of each attribute by both construct reliability and Cronbach's alpha coefficient. The obtained results for both reliabilities indicators are above the threshold of 0.7 indicating high reliability for all constructs (Fornell & Larcker, 1981).

Table 4. Characteristics of the final sample.

		Number	%
Public Sector		164	50%
	Shareholder	0	0 %
	SCM administrator	5	1.5 %
	Stakeholders	75	22.9 %
	Patients	84	25.6 %
Private Sector		164	50 %
	Shareholder	8	2.4 %
	SCM administrator	15	4.6 %
	Stakeholders	96	29.3 %
	Patients	45	13.7 %
Total		328	100%

For the assessment of the validity, we calculated the Average Variance Extracted (AVE). AVE values are ranging from 0.5 and 0.56 demonstrating a good convergent validity of the constructs (Nusair & Hua, 2010). Table 5 shows the detailed validity and reliability results of our model. The table also summarises the results of our hypotheses by presenting the standardised coefficients and goodness-of-fit model indicators.

The results of our measurement model indicate that factor loadings are significant. The measured variables factor loadings of Strategic Planning, Customer Satisfaction & Retention and Business Results are all above the threshold of 0.7 and are statistically significant at 0.05 level. For Green Process Management and Development & Social Sustainability measured variables, the statistical significance has been reached seeing that the p-value of the factor loading is below 0.05. The three factor loadings of D&SS.2, PM.2 & PM.3 are just below 0.7 can be accepted as they are still greater than 0.5 (Sahin et al., 2007).

Hypothesis testing results of the exogenous and endogenous latent variables are also positive. Paths Analysis outcome supports the statistical significance of the 6 hypothesis of the model (see Figure 4). For H1, the standardised path coefficient SP➔D&SS is 0.77 (P-value <0.05) proving that good strategy and leadership influence positively the Development & Social Sustainability of the organisation. H2 is also confirmed as the path coefficient is equal to 0.32 and is statistically significant at 0.05 level confirming that Strategic Planning has a direct positive effect on Green Process Management.

Public & Stakeholder Responsibility, Learning & Growth and Safety & Risk Management are all important to a GPM. This statement is endorsed by the result of H3 as statistical significance of path D&SS➔GPM coefficient (0.65) is below 0.05 level. H4 and H5 are confirmed as the standardised coefficients of PM➔CSR and PM➔BR are respectively 0.86 and 0.48 with a p-value smaller than 0.05. Finally, H6 is also supported as Customer Satisfaction & Retention has a direct effect on Business Results (Standard path coefficient equal to 0.46, p-value <0.05).

The metrics of goodness of model fit to data shows also that data supported the proposed structural equation model. The values of $\chi^2 = 108.97$, Df = 71, χ^2/Df = 1.535 are below the recommended threshold of 3 proving that each measurement model fit the data sample well. The GFI = 0.955 and CFI = 0.981 are higher than 0,9 suggesting an excellent model fit.

Table 5. SEM results.

Constructs	Variables	Standard Loadings	p-value	Construct Reliability	Cronbach's α	AVE	Model Statistics	Goodness of fit
SP				0.701	0.847	0.540		
	SP.1	0.728	***					
	SP.2	0.741	***					
D&SS				0.758	0.882	0.511		
	D&SS.1	0.693	***					
	D&SS.2	0.735	***					
	D&SS.3	0.715	***				χ^2	108.970
GPM				0.802	0.907	0.503	Df	71
	GPM.1	0.717	***				χ^2/Df	1.535
	GPM.2	0.69	***				p-value	0.003
	GPM.3	0.688	***				GFI	0.955
	GPM.4	0.741	***				CFI	0.981
CSR				0.714	0.854	0.555	RMSEA	0.04
	CSR.1	0.717	***					
	CSR.2	0.772	***					
BR				0.751	0.879	0.502		
	BR.1	0.713	***					
	BR.2	0.708	***					
	BR.3	0.704	***					

***factor loading is significant at p-value <0.001.

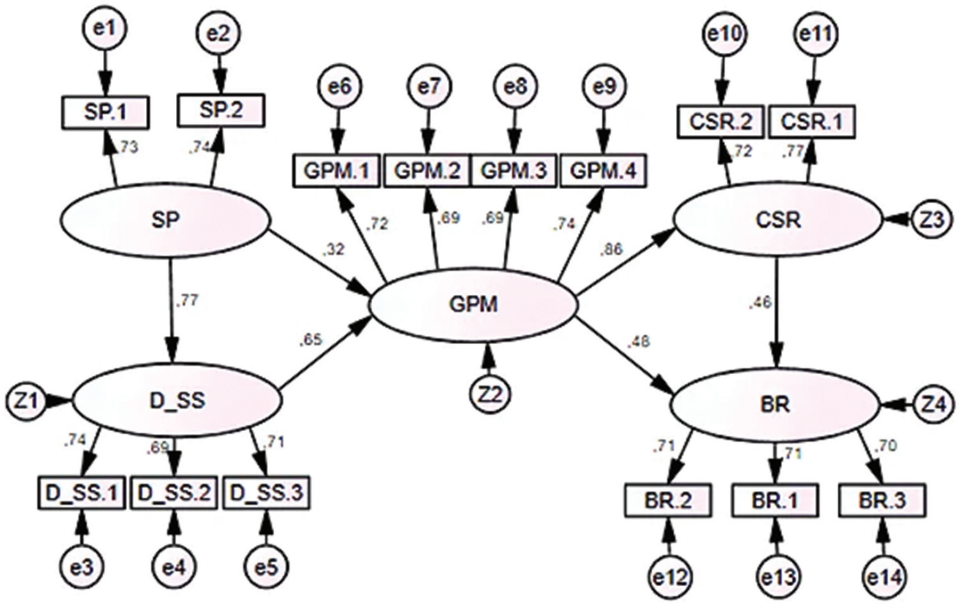


Figure 4. SEM hypothesis factor loadings.

Finally, the RMSEA = 0.04 and model's p-value = 0.003 are all satisfactory indicating that no post-hoc modification of the model is needed.

These findings have several managerial implications. Hospitals should not assess or view their practices independently, instead a systems approach should be employed. Comparing to the existing models in the literature, the proposed framework covers generically the overall hospital supply chain. The selected criterions can gauge the performance of each process independently if it's a care/patient flow process or pharmaceuticals/physical flow process (Ziat et al., 2019). Moreover, the research empirically demonstrates the links between the various performance criterions existing within the literature. Thus, hospital managers may utilise this information to successfully develop a general supply chain management strategy that will result in a sustainable performance.

5. Conclusion

The increased competitiveness in the healthcare sector forced the organisations to gain a competitive advantage through costs reduction without jeopardising the patient safety and service quality. The challenge is to ensure patient satisfaction while achieving higher efficiencies. Hence, healthcare professionals focused on developing performance management systems in order to set targets, measure the gaps between organisational goals and daily operational tracked metrics and finally identify areas of improvements.

The scientific state of the art identifies the healthcare performance management topic as a multidimensional problem by nature. Thus, the combined method of Fuzzy Delphi Method and SEM proposed in this article is efficient in tackling a Multiple Criteria Decision-Making problem. We applied FDM first to eliminate the imprecision and the subjectivity related to the panel experts' opinions while rating the most relevant performance criteria from an expert perspective. Afterwards, SEM is used to quantify the weightages and the interdependencies of the selected criteria that forms the performance model.

Our Model proposes five performance pillars for healthcare performance management along with 14 sub-criteria. It was developed to take in consideration and gauge all three dimensions of sustainability starting with Business Results and Customer Satisfaction & Retention, which have a direct impact on the economic dimension of SSCM. The healthcare organisations responsibility towards the environment has been integrated in the Green Process Management pillar. This pillar enables organisation to measure the efficiencies of the SSCM processes while proactively track waste generation of each process of the supply chain. Development & Social sustainability pillar promotes the wellbeing and the continuous improvement of stakeholders and society within the organisation. The criteria of the fifth pillar the Strategic Planning should be implemented to evaluate the organisation's strategy, culture and leadership in terms of sustainability.

This study proposes a benchmark decision-making tool. Considering not only expert judgement, our sustainable performance management system also incorporates the customer and stakeholders' opinions providing a holistic overview of the SSCM. Hospital administrators can extend our model in future research to micro-operational level specific to their supply chain configuration in order to monitor the organisation performance. This conceptual framework metrics are strategic and tactical objectives aspired globally but needed to be proven quantitatively with real time KPIs to improve the sustainability of their organisation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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