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Reference


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STRUCTURAL EQUATION MODELING IN A RATIONALIZATION TENTATIVE OF BALANCED SCORECARD

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A. STANCU
Abstract: This paper examines the relationship between structural equation modeling and the balanced scorecard in a health care institution. Using financial and non-financial data taken from the social-medical establishment, the paper propose a rational construction of Balanced Scorecard by choosing the right indicators for the right axes. This choice is made by implementing the Partial Least Squares (PLS) in our model. In addition, the scheme gives us the cause-and-effect chain, the one described by Kaplan and Norton as: measures of organizational learning and growth -> measures of internal business processes -> measures of the customer perspective -> financial measures. We will observe that is a health care institution the cause-and-effect chain will change as the primordial goal for a medical-social establishment is not maximizing profitability, but maximizing patient satisfaction. At the end of our article we will proceed to a comparison between two SEM methods: Covariance Based Method (CBM) and Partial Least Squares (PLS).
Biographical notes: Morard Bernard is a full professor of Accounting Management at the University of Geneva. He is the author of several books of Cost Controlling and Accounting Management as well as several articles of Balanced Scorecard and its implementation in medical and social establishments.

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Keywords: Balanced Scorecard (BSC), Structural Equation Modeling (SEM), Partial Least Squares (PLS), Social-medical establishment or health care unit.

1. Introduction

A new concept of strategic management was developed in the early 1990's by Drs. Robert Kaplan from Harvard Business School and David Norton. They named this system the 'Balanced Scorecard'. Distinguishing some of the weaknesses and ambiguity of previous management approaches, the balanced scorecard approach provides a clear direction as to what companies should measure in order to 'balance' the financial point of view.

The Balanced Scorecard embodies a set of measures that gives top managers a quick but comprehensive vision of the business. The balanced scorecard contains financial measures that tell the consequences of actions already taken. And it complements the financial measures with operational measures on customer satisfaction, internal processes, and the organization's innovation and improvement activities – “operational measures that are the drivers of future financial performance” (Kaplan & Norton 1992).

One criticism of the Balanced Scorecard is the construction of it. Even if the authors give us some leading points and tell us the paces in the realization of the BSC, the
concept are quite ambiguous and very hard to apply in the enterprises environment. A modeling of the system is demanded and also an approach of the theory to applicability.

Another trend in recent years we can observe in several papers in leading accounting journals that have considered on the future directions of management accounting research, including the structures of theoretical modeling and data analysis that can be used (Shields 1997, Atkinson et al. 1997, Fisher 1995). Within this environment the use of structural equation modeling (SEM) provides simultaneous tests of measurement reliability and structural relations, which may overcome some of the limitations that have been leveled at the way that management accounting has used more traditional statistical techniques (Smith 2004).

There are three objectives underlying this paper. The first objective is to combine these concepts together and try to pose several assumptions for a rational construction of a BSC using PLS methodology. This is demonstrated with a health care institution case where we have 10 indicators and 100 periods for each. We will take the indicators that can be used for each axis, and we give a rational explication for this choice. We will also generate the cause-and-effect chain and observe which latent variable (axis) are influencing and which are to be influenced. Our second objective is to do a comparison between Covariance Based Method (CBM) and Partial Least Squares (PLS). We will see that even if the 2 methods give us quite the same result, the PLS it has stronger links with each indicator, bigger T-Values and lower standard errors, thus validating the model. The final objective is to try creating a pragmatic model that can be implemented in the enterprises environment, thus modeling the theory of Balanced Scorecard.

The paper is structured as follows. In the following session we will introduce the concepts and we will connect them. This is followed by an example of social-medical establishment in which we will implement the PLS method to create a rational Balanced Scorecard. The third part will be a comparison between Covariance Based Method (CBM) and Partial Least Squares (PLS) where the same case is solved with two different programs. Finally, we will post a tentative modeling of Balanced Scorecard that can be implemented in enterprise environment.
2. The need for a new validation methodology

The balanced scorecard is a management system (not only a measurement system) that enables organizations to clarify their vision and strategy and translate them into action. Thus the balanced scorecard provides executives with a comprehensive framework that translates a company's strategic objectives into a coherent set of performance measures. It provides feedback around both the internal business processes and external outcomes in order to continuously improve strategic performance and results. When fully deployed, the balanced scorecard transforms strategic planning from an academic exercise into the nerve center of an enterprise. According to Fielden (1999), corporations across the world have begun leveraging the power of balanced scorecards for converting vision and strategy into measurable targets.

The balanced scorecard can serve as the focal point for the organization's efforts, defining and communicating priorities to managers, employees, investors, even customers (Kaplan & Norton 1993). With the four perspectives, the balanced scorecard minimizes information overload by limiting the number of measures used and forces managers to focus on the handful of measures that are most critical. It therefore enabled companies to track financial results while simultaneously monitoring progress in building the capabilities and acquiring the intangible assets they would need for future growth (Kaplan & Norton 1996). Balanced Scorecards provide executives with the ability to develop measures that could accurately forecast the health and wealth of an organization. By providing the ability to translate strategy into action rapidly, measurably, and knowledgeably, a balanced scorecard aligns that strategy within an organizational structure to tap into hidden assets and knowledge. Moreover, by connecting both internal and external people with these strategies, continual learning and growth can be achieved (Pineno C. 2002).

However, the balanced scorecard has problems with some of its key assumptions and relationships. First, there is not a causal but rather a logical relationship among the areas analyzed. Customer satisfaction does not necessarily yield good financial results. Assessing the financial consequences of increased customer satisfaction or quality improvements requires a financial calculus. Chains of action which yield a high level of
customer value at low costs lead to good financial results. This is not a question of causality; it is logic since it is inherent in the concepts. Therefore, the balanced scorecard makes invalid assumptions, which may lead to the anticipation of performance indicators which are faulty, resulting in sub-optimal performance. Second, the balanced scorecard is not a valid strategic management tool; mainly because it does not ensure any organizational rooting, but also because it has problems ensuring environmental rooting. Consequently, a gap must be expected between the strategy expressed in the actions actually undertaken and the strategy planned (Nørreklit H., 2000).

Within this general environment of criticism and uncertainty, some writers (Shields 1997, Shields and Shields 1998) have called on management accounting researchers to make greater use of structural equation modeling (SEM). SEM is a statistical technique that allows the simultaneous analysis of a series of structural equations and it may be regarded as a family of techniques (encompassing path analysis, partial least squares models, and latent variable SEM). However, there appears to be some agreement that all SEM models involve two aspects: first, the estimation of multiple interrelated dependent relations between variables, and second the ability to represent latent variables in these relations while accounting for estimated measurement error associated with the imperfect measurement of variables. This method is particularly useful when a dependent variable in one equation becomes an independent variable in another equation (Hair et al. 1998).

An important issue to remark is that of sample size. A suggested rule of thumb for SEM is a minimum sample size of 100 (Medsker et al. 1994). However, it has also been suggested that a sample size of 200 may be required to generate valid fit measures and to avoid drawing inaccurate inferences (Marsh et al. 1988, James and James 1989, Boomsma 1982, Medsker et al. 1994).

Despite these cautions, Smith and Langfield-Smith find out in one of their articles that only eleven of the 20 studies (55%) surveyed had samples smaller than 200. Even if the recommended sample size of 100 is considered the lower bound of acceptability, three of the 20 studies (Magner et al. 1996, Chalos and Poon 2000, Abernethy and Lillis 2001) fall below this benchmark, meaning that the inferences drawn from these studies could be challenged.
Some management accounting researchers may be discouraged from using covariance based methods due to the large sample size requirements, and the assertion that the technique is only appropriate in areas where theory is relatively strong. While these limitations are true of latent variable SEM techniques, Partial Least Squares (PLS) modeling provides an alternative.

Partial Least Squares (PLS) regression is a recent technique that generalizes and combines features from principal component analysis and multiple regression. It is particularly useful when we need to predict a set of dependent variables from a (very) large set of independent variables (i.e., predictors). It originated in the social sciences (specifically economy, Herman Wold 1966) but became popular first in chemometrics (i.e., computational chemistry) due in part to Herman’s son Svante, (Geladi & Kowalski 1986) and in sensory evaluation (Martens & Naes 1989). But PLS regression is also becoming a tool of choice in the social sciences as a multivariate technique for non-experimental and experimental data alike (neuroimaging, see McIntosh, Bookstein, Haxby, & Grady, 1996). It was first presented as an algorithm akin to the power method (used for computing eigenvectors) but was rapidly interpreted in a statistical framework. (Herve 2003).

The use of PLS, despite its inherent limitations (most notably, that it is a limited-information technique, designed to maximize prediction, rather than fit), appears to be a way in which statistical modeling in management accounting research can move forward without the need to obtain large samples, something which management accounting researchers have traditionally found difficult. Another benefit of PLS is the technique's ability to accommodate non-normal data, due to the less rigorous assumptions underpinning the technique (Smith & Langfield-Smith 2004).

3. Linking BSC with PLS

The article "Optimal Design for Balanced Scorecard map: Application in A Health Care Institute for Elderly" published by Bernard Morard et al. (2002), share the dilemma suggested by Ittner and Larckner affirming that "(...) decisions using
multicriteria performance measurement systems should be computed using explicit, objective formula that prescribes the weights to be attached to each measure, or should be based on subjective evaluations where the weights to be attached to each measure is implicitly or explicitly chosen by the decision maker” (Ittner & Larckner 1998) to build, check and validate assumptions of causality relationship between the indicators within the framework of the implementation of Balanced Scorecard in a medico-social establishment, while following the application of a PLS system.

In the article, it is proposed an analytical approach which defines Balanced Scorecard according to a multidimensional cost approach, while postulating that the financial survival of a company is the indispensable condition to achieve the goals of the three other perspectives, which in the case of the medico-social establishment are the perspective "patient", the perspective "employee" and the perspective "internal process". Morard puts forth the following assumptions: "the strategy of a health care institution aims to maximize the patient’s comfort and well-being (patient perspective) which is achieved through providing adequate care services and accommodation structure (internal process perspective) to the patient. To insure the continuity and the quality of the service to the patient, the employees need to be motivated, which can be achieved through training and career development plans – possible indicators of the employees’ (or learning and growth) perspective. Finally, at the bottom, the financial function (a constraint to be respected) enables the realisation of the three previous perspectives and represents" (Morard 2002). Figure 1 compares the causal relationship between the four generic prospects for Balanced Scorecard with the causal sequence suggested in the case of our idea.

We state that the assumptions of causality relationship between the four latent variables, represented by the four perspectives in figure 1, remain subjective. This is why we propose the use of a model of structural equations to show in a more objective way the force of the links between the latent variables expressed by sets of measurable indicators. Indeed, if the choice of the perspective and the assumptions which bind them remain subjective, the model of structural equations proposes "to provide a meaningful and parsimonious explanation for observed relationships within a set of measured variables" (MacCallum 1995).
Before going into fine details, Morard explains why in a system of structural equations we find latent variables which cannot be measured directly and exactly. These latent variables need measurable variables, which are expressed through indicators which can be directly observed and measured. The system of structural equations is based on a factorial analysis (exploratory or confirmatory, according to the specific case) of the data to define and validate the way of the causal relations which constitutes the architecture of Balanced Scorecard. We stress that one of the limits inherent to the application of a system of structural equations in the context of Balanced Scorecard, is the pre-necessary statistics necessary to the standardization of the data, which requires an important quantity of observations significantly to confirm the results obtained. The collection of a great quantity of data is not obvious, especially in small and medium-sized companies. This is why the application of the PLS is better in this case.

Figure 1: Comparison between the original perspectives of the BSC and those in the case of Morard.
4. The hospital case

To illustrate the application of the PLS method, as a tool allowing to validate the construction of Balanced Scorecard within an organization, we will use the observations drawn from a study on a medico-social establishment. This study was carried out by the researchers of High Commercial Studies in the University of Geneva. Initially, we will present the case by describing the indicators selected. Then, we will try to define the strategy of the MSE while following the approach of Kaplan and Norton. We will illustrate the steps to be followed to validate the construction of the BSC through the use as of PLS. In order to validate our starting assumptions, we will compare our results with those found with Lisrel using covariance-based method (CBM). Finally, we will draw the conclusions from our case study.

4.1 Case presentation

Our case study is based on data resulting from a medical establishment located in Switzerland. It is true that the branch of industry and the objective of the institute do not represent, a priori, the typical case of a company with a lucrative goal. However, we were interested in this case for a principal reason: the availability of data concerning one important period. Indeed, we encountered difficulties to have access to countable data or not-accountants over one sufficiently long period. The MSE had to consider setting up a BSC and had thus been interested in the constitution of a base of indicators. The ideal condition for the construction of the BSC would be to build indicators on the basis of beforehand established strategy. However, the project was then given up and the data thus collected do not certainly represent the ideal conditions for a demonstration. In our precise case and considering the difficulty in obtaining real data and the time at disposal for the development of this work, they constitute an interesting starting base to build an illustration. The raw data were collected by the MSE and were selected by the members of the direction of the MSE, as being the most important to control values in term of management. These data, giving place to the construction of indicators, could already be used like a management tool.
Below, we find the list of the indicators created which was communicated to us. It consists of 10 indicators which represent financial and organizational aspects as well as customer satisfaction:

- Occupancy rate (OCCUPANCY), expressed through the ratio between the number of beds occupied by the patients and the total number of beds in the MSE;
- The personnel/patients ratio (PERSOPAT), which measures the total number of people employed by the MSE divided by the total number of patients;
- The turn-over rate (TURNOVER), expressed by the ratio between the number of people employed at the MSE which left their work and the total number of people employed at the MSE;
- The medical personnel/patients ratio (MEDPERSPAT), which measures the effective number of the medical personnel at disposal for each patient;
- Satisfaction rate (SATISFACTION), measured by the number of patients who expressed a total satisfaction (estimated through an evaluation carried out by the means of a questionnaire) divided by the total number of patients;
- The impotence ratio (IMPOTENCE), expressed by the ratio between the patients who are in a state of total dependence, thus requiring an action of the medical personnel and the total number of patients;
- Total number of patients (PATIENTS);
- The medical fees/charge ratio (FEESCHARGE), which measures the relationship between the total fees made by the doctors and the total of running costs of the MSE;
- The salaries/charge ratio (SALCHARGE), measurement the ratio between the total of wages and the total load of exploitation;
- Rate of subsidized patients (SUBSIDPAT), which measures the number of patients profiting from an additional financial assistance from the State divided by the total number of patients.

In the following part, we will outline the construction of the BSC for the MSE by gathering these indicators while trying to define a causal sequence between the various perspectives.
4.2 The construction of Balanced Scorecard for the MSE

In this part, we will define the perspectives and will outline the strategic chart of our model of the BSC. Then, we will establish which are the indicators estimating each perspective best.

4.1.1 Definitions of the axis

We take as a starting point the article of Morard and al. (2002), making the assumptions of causal relations which we described in section 3.

- The "customer satisfaction" perspective;
- The "organizational" perspective and
- The "financial" perspective

Kaplan and Norton recommend the decomposition of the strategy in four prospects. However, we limited ourselves, in this precise case, to determine only three perspectives. In fact, we also mentioned it before, the number of indicators which we have at our disposal are not sufficient to build four latent variables. Moreover, by being preoccupied with giving a simplified illustration, we decided to reduce the number of perspectives. It seems important to specify that the construction of the model (the choice of the indicators and the sequences, which we will describe hereafter) simplify the steps to be followed to demonstrate the installation of the BSC in an organization. These assumptions are based neither on a scientific step, nor on a terrain survey, but simply on a plausible construction of links. It is thus by the method which will follow that we will be able to affirm or infirm our model of the BSC for the MSE. The strategy of our MSE can be described in the following way: the principal goal of the MSE is to maximize the satisfaction of its customers by guaranteeing the best level of comfort and possible wellbeing (perspective "customer satisfaction"). To ensure the quality and the continuity of the customer service, the MSE must have comfortable and functional structures and motivated medical personnel, available and qualified ("organizational" perspective). Finally, the MSE must be provided with structures and adequate personnel to reach the
satisfaction of its customers. It is thus essential that the MSE has at disposal the necessary financial resources ("financial" perspective).

4.1.2 Attribution of indicators to the axis and description of the strategic chart

The three perspectives are represented by latent variables which are expressed through directly measurable indicators. By the means of an exploratory factorial analysis, we arrived at the following distribution of the indicators by perspectives:

In the table 1 we can see the factorial analysis between our variables.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Financial Perspective</th>
<th>Organizational Perspective</th>
<th>Satisfaction Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCCUPANCY</td>
<td>-0.02</td>
<td>0.15</td>
<td>0.09</td>
</tr>
<tr>
<td>PERSOPAT</td>
<td>0.01</td>
<td>0.43</td>
<td>0.12</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>0</td>
<td>0.62</td>
<td>0</td>
</tr>
<tr>
<td>SATISFACTION</td>
<td>0.08</td>
<td>-0.02</td>
<td>-0.22</td>
</tr>
<tr>
<td>MEDPERSPAT</td>
<td>0.01</td>
<td>0.31</td>
<td>0</td>
</tr>
<tr>
<td>IMPOTENCE</td>
<td>0.14</td>
<td>0.34</td>
<td>0.04</td>
</tr>
<tr>
<td>PATIENTS</td>
<td>0</td>
<td>0</td>
<td>0.39</td>
</tr>
<tr>
<td>FEESCHARGE</td>
<td>0.66</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SALCHARGE</td>
<td>0.21</td>
<td>0.19</td>
<td>-0.07</td>
</tr>
<tr>
<td>SUBSIDPAT</td>
<td>0.42</td>
<td>0.19</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

Table 1: Factorial analysis of our indicators

In the table above, we observe the results obtained by the Lisrel software at the time of the exploratory factorial analysis (TSLS). We gathered the factors that gave the biggest link with each perspective. To allow a greater number of degree of freedom and to construct more suitable axis, we made an exception for parameter OCCUPANCY and add it to the "satisfaction" perspective.

According to the results obtained in the table above, we will establish the link between the indicators and the perspectives (strategic chart) in the following way:
Concerning the "financial" prospect, the latent variable is expressed through the indicators rate of subsidy (SUBSIDPAT), the ratios wages/charge (SALCHARGE) and medical fees/charge (FEESCHARGE). Thus, the patients profiting from an additional help of the State, represent the more profitable customers for the MSE. The medical wages and fees represent, as for them, a great part of the total loads of exploitation. Consequently, an efficient management of this expenditure would make it possible to have a larger availability of financial resources in the goal to improve, for example, the structures and the comfort of the MSE.

With regard to the "organizational" perspective, this latent variable is expressed through the indicators turn-over (TURNOVER), rate of impotence (IMPOTENCE), personnel/patient ratio (PERSOPAT) and medical personnel/patient ratio (MEDPERSPERS). The turn-over and the two ratios, give us an indication on the working conditions of the personnel in the MSE. Indeed, an important turn-over, can indicate us dissatisfaction and bad working conditions reigning in the institute. Furthermore, the financial resources at disposal to the MSE do not make it possible to allocate wages or structures sufficient to encourage the development of consumer loyalty of the long-term personnel. The same reasoning is valid for the personnel/patient and medical personnel/patient ratios. Indeed, if the personnel at disposal are not sufficient for the patients, the employees will see themselves constantly subjected to an important factor of stress, generating low working conditions. Thus, the employees would have a main tendency to leave their work.

The personnel evolving/moving under bad working conditions, in addition little remunerated and in a constant change of relational environment, would have a negative effect on the availability towards the patients and quality of work. Indeed, the fact that the personnel/patient and medical personnel/patient ratios are weak, can give us indications over time to provision for each patient. Moreover, a high rate of turn-over would not make it possible to start personal relations between the personnel and the patients, thus limiting the contact to cold and professional relations. This could have a negative influence as much on the satisfaction of the patients as well as on the professional blooming of the employees. Finally, the rate of impotence also plays an important part. Indeed, more this rate is raised, and the time at disposal of medical
personnel for other patients decreases. That could have consequence on the frustration of the personnel as well as on the satisfaction of the patients.

To finish, the "customer satisfaction" perspective is expressed by the means of the rate of satisfaction (SATISFACTION), the number of patients (PATIENTS) and the occupancy rate (OCCUPANCY). The rate of satisfaction tests in a total way the level of the service offered by the institute. Compared to the second indicator, plus the number of patients is raised, less the quality of the service will be perceived by the boarders caetiris paribus. Finally, the same reasoning is also valid for the occupancy rate. Figure 2 below schematically represents the sequence which we have just described and various links between the indicators (in form of square) and the latent variables (in form of ellipses).

\[ \text{Figure 2: The BSC scheme of the MSE} \]
After having outlined the BSC for the MSE, in the following part, we will illustrate the steps to be followed to validate the construction of the BSC through the use of PLS.

4.2 Illustration of the PLS application to the case study

In this part, we will initially analyze our data to ensure us that they observe the requirements for the application of PLS through the PLSGraph software. We will test then the validity of our model of BSC. Finally, we will proceed to a comparison with Lisrel results using covariance-based method.

4.2.1 Analyze raw data

To apply PLS, several conditions must be respected. First condition is that an analysis of the raw data is necessary. We will concentrate on two points: sample size and the principle of the multicollinearity. Let us still specify that the normality and the scale of the data were checked beforehand.

The use of PLS can be done at various levels: it is possible to apply a model of transverse equation or a longitudinal model. In our case, we have considered more suitable the use of transverse approach. To allow a validation of assumptions in SEM – Covariance-based methods, it is then necessary to have a sample of a sufficiently large size (between 200 and 500 observations). However, it is difficult in our situation to obtain such a number of observations of a company. That is why the use of PLS would be of a greater use when our observation size is not very large.

4.2.2 The principle of the multicollinearity

It is necessary that the indicators of each prospect are not subjected to the principle of multicollinearity, nor with a strong correlation. Indeed, two strongly correlated indicators would explain the same phenomenon or the same variation of variance by complexing the general model unnecessarily. This is why we will carry on,
by means of SPSS software, an analysis of the correlation between all the indicators of the model which was proposed before (Figure 2). Admittedly, the bivariated correlation should not be regarded as the factor determining for the success of a PLS analysis. However, it gives us already a first indication of the links which the indicators have between them.

Table 2: Correlation table between the MSE indicators

We can observe, in table 2, that the various correlations obtained are not very high. Indeed, the results obtained are included/understood in an interval of -0.4 and 0.4. This report makes it possible, initially, to launch a PLS analysis without fearing an obvious problem of multicollinearity between two factors.
4.2.3 Use of PLSGraph software to test the validity of Balanced Scorecard

In this part, we will use the PLSGraph software which, as mentioned above, is a tool to test the models of PLS. Before being able to validate a model as a whole, it is necessary to test locally if the indicators are good estimators of the latent variable. We will thus proceed in the following part to an analysis of each perspective. With this intention, we will evaluate the validity of the local model through the values of the standardized coefficients and T-Value obtained between the perspectives and its indicators. Let us specify that the generally allowed values to validate the relations must be:

- > 0.3 for the standardized coefficients
- > 2 for T-Values
- < 0.2 for Standard error

Even if the values are a little tighten, we choose them in order to see if the PLS method is indeed as powerful as it seems.

It should be underlined the fact that a model can go very well locally, but the sum of the various models tested locally does not guarantee the correct operation of the total model. However, this process will enable us to have tracks of analysis and to determine at which level the problem is. Conversely, at local level, an indicator which would result weak estimator for the latent variable, it could be a more powerful indicator in the total model. Indeed, the great number of interactions inside the total model can influence positively or negatively the various coefficients.

Test of the "financial" perspective

As we have already mentioned, the three factors retained for this latent variable are as follows: FEESCHARGE, SALCHARGE, and SUBSIDPAT. The results obtained in figure 3 shows the "paths coefficients" between the indicators (represented by the rectangles) and the latent variable (represented by an ellipse). The loadings and the weights (in brackets) are marked near the representative arrow. The residual value for
each indicator is in the left part. After each graphic a table with output results is represented.

![Diagram](image.png)

*Figure 3: Estimated coefficients for “finance” perspective*

<table>
<thead>
<tr>
<th>Outer Model Weights</th>
<th>FINANCE</th>
<th>Original sample estimate</th>
<th>Mean of subsamples</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINANCE</td>
<td>FEESCHARGE</td>
<td>0.4461</td>
<td>0.4431</td>
<td>0.0417</td>
<td>10.7025</td>
</tr>
<tr>
<td></td>
<td>SALCHARGE</td>
<td>0.4145</td>
<td>0.4163</td>
<td>0.0399</td>
<td>10.3788</td>
</tr>
<tr>
<td></td>
<td>SUBSIDPAT</td>
<td>0.4934</td>
<td>0.4882</td>
<td>0.0347</td>
<td>14.2305</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outer Model Loadings</th>
<th>FINANCE</th>
<th>Original sample estimate</th>
<th>Mean of subsamples</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINANCE</td>
<td>FEESCHARGE</td>
<td>0.7263</td>
<td>0.7269</td>
<td>0.0721</td>
<td>10.0744</td>
</tr>
<tr>
<td></td>
<td>SALCHARGE</td>
<td>0.6748</td>
<td>0.6822</td>
<td>0.0612</td>
<td>11.0188</td>
</tr>
<tr>
<td></td>
<td>SUBSIDPAT</td>
<td>0.8032</td>
<td>0.7999</td>
<td>0.0525</td>
<td>15.3038</td>
</tr>
</tbody>
</table>

*Table 3: Output results for “finance” perspective*
The results obtained are more than satisfactory in figure 3. Indeed, the coefficients have values higher than 0.3. In fact, we can observe a strong correlation between the indicators and the latent variable as all loadings are greater than 0.65. Moreover, we observe in the table 3 that the T-Values are much higher than the acceptable minimal threshold. The standard errors for model weights and loadings are below 0.1. Consequently, we consider that the indicators are relevant estimators of the "financial" prospect.

**Test of the "organizational" perspective**

We will now test the validity of the model for the "organizational" perspective. With this intention, let us recall that the indicators retained at the time of the exploratory factorial analysis were: PERSOPAT, MEDPERSPAT, IMPOTENCE and TURNOVER.

![Diagram](image-url)

*Figure 4: Estimated coefficients for “organizational” perspective*
Table 4: Output results for “organizational” perspective

For indicators TURNOVER, MEDPERSPAT and IMPOTENCE, the results obtained in the figure 4 are satisfactory and, consequently, adequate to consider the "organizational" perspective. If we analyze the table 4 we can see that for the three indicators discussed above we have a standard error and a T-Value that corresponds to our needs. Even if for the MEDPERSPAT indicator we have a standard error for its loading of 0.1556, we can compensate it with its T-Value of 3.7332, validating thus the model.

On the other hand, indicator PERSOPAT proves to be a weak estimator of the latent variable having also a high residual value. The T-Values for this indicator for both loadings and weights are below its limits. We can observe also that the standard error is a little bit above the 0.2 limit for the loadings model. We thus tested the model by
disregarding indicator PERSOPAT and we noticed that it was as a whole, less good than that presented above. Finally, we retained the model presented like most complete testing the "organizational" prospect.

**Test of the "satisfaction" perspective**

It remains us to test the validity of the model for the "satisfaction" perspective. The indicators selected were: OCCUPANCY, SATISFACTION and PATIENTS. The results obtained by the means of PLSGraph software are below:

![Diagram showing estimated coefficients](image)

*Figure 5: Estimated coefficients for “satisfaction” perspective*

<table>
<thead>
<tr>
<th>Outer Model Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATISFACTION</td>
</tr>
<tr>
<td>OCCUPANCY</td>
</tr>
<tr>
<td>SATISFACTION</td>
</tr>
<tr>
<td>PATIENTS</td>
</tr>
</tbody>
</table>
### Outer Model Loadings

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Original sample estimate</th>
<th>Mean of subsamples</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATISFACTION</td>
<td>-0.5516</td>
<td>-0.5437</td>
<td>0.3085</td>
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</tr>
<tr>
<td>OCCUPANCY</td>
<td>0.6426</td>
<td>0.5592</td>
<td>0.3117</td>
<td>2.0618</td>
</tr>
<tr>
<td>PATIENTS</td>
<td>0.7206</td>
<td>0.6662</td>
<td>0.2104</td>
<td>3.4252</td>
</tr>
</tbody>
</table>

*Table 5: Output results for “satisfaction” perspective*

Contrary to the two other prospects, we observe that the indicators are not very good estimators of the latent variable. At a premier view the first and the third indicators looks good if we analyze figure 5. We observe a good correlation with strong loadings and weights and with low residual values. However, if we have a closer look at table 5, we remark that for indicator OCCUPANCY we have a high standard error. It is true that we can compensate this with a T-Value that it is little above 2, but it still remains a question mark.

The coefficients (loadings and weights) for the SATISFACTION indicator are very low. In fact we can observe a strong minus correlation with the latent variable. More than that, the standards errors and the T-Values for both loadings and weights are far from their limits. We have already had a doubt for the choice of the indicators for the "satisfaction" perspective at the time of the exploratory factorial analysis. However, within sight of low number of indicators at our disposal, we are forced to keep the whole indicators expressing this perspective, even if the links are not satisfactory.

The last indicator (PATIENTS) is the sole that is well linked with the latent variable, having a strong correlation and a relatively good standard error and T-Value. However, considering the whole model, it can prove that the various relations and links can, either to reinforce or to attenuate for the "satisfaction" perspective.
Test of model BSC of the MSE

After having tested the various sub-models, we now will stop on the model of the BSC which we worked out, in order to test the correlation assumption. In the figure below, we observe our structural diagram for the model of the BSC.

Figure 6: Structural diagram for BSC model of MSE using PLS
## Outer Model Weights

<table>
<thead>
<tr>
<th>SATISFACTION</th>
<th>Original sample estimate</th>
<th>Mean of subsamples</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCCUPANCY</td>
<td>0.1024</td>
<td>0.1336</td>
<td>0.2407</td>
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<tr>
<td>SATISFACTION</td>
<td>0.7065</td>
<td>0.6787</td>
<td>0.1815</td>
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<tr>
<td>PATIENTS</td>
<td>-0.6406</td>
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<td>3.5983</td>
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</table>

<table>
<thead>
<tr>
<th>ORANIZATION</th>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>PERSOPAT</td>
<td>0.4576</td>
<td>0.4493</td>
<td>0.1088</td>
<td>4.2071</td>
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<tr>
<td>TURNOVER</td>
<td>0.4866</td>
<td>0.4843</td>
<td>0.0802</td>
<td>6.0701</td>
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<tr>
<td>MEDPERSPAT</td>
<td>0.2199</td>
<td>0.2144</td>
<td>0.1118</td>
<td>1.9664</td>
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<tr>
<td>IMPOTENCE</td>
<td>0.4099</td>
<td>0.3955</td>
<td>0.0826</td>
<td>4.9495</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>FEESCHARGE</td>
<td>0.3561</td>
<td>0.3432</td>
<td>0.0906</td>
<td>3.9300</td>
</tr>
<tr>
<td>SALCHARGE</td>
<td>0.4454</td>
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<td>0.0907</td>
<td>4.9133</td>
</tr>
<tr>
<td>SUBSIDPAT</td>
<td>0.5439</td>
<td>0.5394</td>
<td>0.0855</td>
<td>6.3621</td>
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</table>

## Outer Model Loadings

<table>
<thead>
<tr>
<th>SATISFACTION</th>
<th>Original sample estimate</th>
<th>Mean of subsamples</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
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<td>OCCUPANCY</td>
<td>-0.0470</td>
<td>0.0120</td>
<td>0.2742</td>
<td>0.1714</td>
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<tr>
<td>SATISFACTION</td>
<td>0.7780</td>
<td>0.7472</td>
<td>0.1765</td>
<td>4.4072</td>
</tr>
<tr>
<td>PATIENTS</td>
<td>-0.7105</td>
<td>-0.6460</td>
<td>0.1897</td>
<td>3.7450</td>
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</table>

<table>
<thead>
<tr>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSOPAT</td>
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<td>0.5423</td>
<td>0.1220</td>
<td>4.5988</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>0.7459</td>
<td>0.7448</td>
<td>0.0733</td>
<td>10.1729</td>
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<tr>
<td>MEDPERSPAT</td>
<td>0.4352</td>
<td>0.4202</td>
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<td>2.4990</td>
</tr>
<tr>
<td>IMPOTENCE</td>
<td>0.6945</td>
<td>0.6780</td>
<td>0.1020</td>
<td>6.8112</td>
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</table>

<table>
<thead>
<tr>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>FEESCHARGE</td>
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<td>0.6514</td>
<td>0.1208</td>
<td>5.4854</td>
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<tr>
<td>SALCHARGE</td>
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<td>0.7035</td>
<td>0.0841</td>
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<td>SUBSIDPAT</td>
<td>0.8292</td>
<td>0.8257</td>
<td>0.0613</td>
<td>13.5320</td>
</tr>
</tbody>
</table>

*Table 6: Output results for BSC of the MSE*
With regard to the links between indicators and latent variables:

Analyzing the structural diagram for BSC model of MSE (figure 6) we can easily see that the links have strongly reinforced. It means that the model as a whole works better than locally.

“Finance” perspective remained the best latent variable. The FEESCHARGE and SUBSIDPAT indicators enforced the link, with higher loadings. The SALCHARGE and SUBSIDPAT indicators enforced the link with higher weights. The standard errors and T-Values from table 6 are more than satisfactory, with a standard errors lower than 0.12 and with T-Values bigger than 3.9 for both loadings and weights.

In the “organization” perspective we can see that the link of PERSOPAT indicator has tightened with bigger loadings and weights. The standard errors and T-Values from table 6 for this latent variable show us that they have ameliorated for PERSOPAT indicator and remained relatively stable for others indicators.

On the other hand, for the “satisfaction” perspective, we notice that the indicators do not estimate in a relevant way the latent variable. In fact the “satisfaction” perspective changed its values radically. Locally, OCCUPANCY and PATIENTS indicators estimated best the latent variable, and in the BSC model, PATIENTS indicator changed its values (loadings and weights) to minus correlation, OCCUPANCY indicator has a poor link with the values neighbored to zero and the SATISFACTION indicator exploded from minus correlation (-0.552 loading and -0.446 weight) to 0.778 loading and 0.707 weight. This means that this indicator estimates better the model as a whole. If we look at table 6 we can remark that standard errors and T-Values are even better than locally (apart OCCUPANCY indicator which saw his T-Value collapsed).

With regard to the links between latent variables:

We can observe from the figure 6 that standardized coefficients from “financial” to “organizational” perspective (0.499) and from “organizational” to “satisfaction” perspective (0.364) are relatively strong. The important fact to notice is standard errors and T-Values for these links (table 7). Thus a standard error value lower than 0.09 and a T-Value higher than 4.04 shows us that we have a strong and reliable model.
<table>
<thead>
<tr>
<th></th>
<th>Original sample estimate</th>
<th>Mean of subsamples</th>
<th>Standard error</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINANCE</td>
<td>0.4990</td>
<td>0.5155</td>
<td>0.0886</td>
<td>5.6330</td>
</tr>
<tr>
<td>ORGANIZATION</td>
<td>0.3640</td>
<td>0.4015</td>
<td>0.0901</td>
<td>4.0402</td>
</tr>
<tr>
<td>SATISFACTION</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Table 7: Path coefficients table for BSC of the MSE*

From this level of results’ analysis, we can underline the fact that the model of Balanced Scorecard of the MSE is reliable and that there are strong and significant relations in the sequence of the three perspectives. We consider that the hypothesis assumption created in the beginning of our article, even if indicators retained for “satisfaction” perspective are not the most adequate estimators.

5  **Which method we choose: PLS or Covariance-based methods?**

We will proceed now to a practical comparison between Partial Least Square and Covariance-Based Methods (CBM). The same database was analyzed with CBM model using Lisrel software. In the figure below we have the comparison between the local latent variables.
In the figure 7, in black color, in the neighborhood of arrows are correlations between indicators and latent variables. The values in blue color just near the correlations values are the T-Values for each indicator. We can easily notice that the PLS method has found by far bigger correlations between indicators and latent variables than covariance-based method (CBM). The residual values that are shown in the left part of the graphics are lesser in the PLS than in the CBM. The facts are more or less normal, as the PLS finds factors that capture the greatest amount of variance in the predictor variables and
seeks to find a single factor that best correlates predictor variables with predicted variables. We commonly say that PLS attempts to maximize covariance; in fact, this is the explicit objective of the SIMPLS algorithm for PLS.

Regarding the T-Values, we remark that all values are bigger in PLS than in CBM. In fact, we notice for some links, the T-Values are even four or five time bigger meaning that the model constructed with PLS is more reliable and stronger than the model constructed with CBM. Another thing to add is that in CBM models we have to choose a starting path, meaning that it is necessary to fix a starting value for one of the coefficients in order to estimate the whole correlation structure. The method required by the Lisrel software is to fix a coefficient with starting value equal to 1. Because of this, we cannot estimate the T-Value for that link.

We have analyzed our latent variables locally, but we would like to compare our results between the whole BSC models constructed with both PLS and CBM. We mention that the model change a lot when we link the latent variables between them, that is why we would like to draw some conclusions regarding this. In the figures below we constructed the two models, one with PLSGraph for PLS and the other with Lisrel for CBM. The black values show us the links’ correlation and the residual values in the extremities, and the blue values shows us the T-Values for every link. One more time, because the path we are forced to choose in Lisrel software, we cannot find the T-Values for it.
Figure 8: Structural diagram for BSC model of MSE using **PLSGraph**

Figure 9: Structural diagram for BSC model of MSE using **Lisrel**
Comparing the two graphics (figure 8 and figure 9), we can see that in all cases the correlations between indicators and latent variables are bigger using PLS method. Also all T-Values are higher in the case of PLS. Regarding the correlations between perspectives, we can notice that the values are relatively bigger using CBM model. However, this higher correlation can be attenuated by a lower T-Value between the axes. Indeed, for PLS model, we have T-Values between latent variables that are higher than 4, which told us that the model is more reliable.

As a conclusion we can say that PLS method is more appropriated for the construction of a BSC model. First of all, in CBM we would need a great number of data, which is pretty hard to find in companies. Normally, a company has 20 periods (semester or trimester), a number which would be insufficient to build a BSC using CBM. As for PLS, we would not need large amount of data, meaning that the model can be validated even if we have less information available. Second of all, looking at our comparison results, we can see that the model constructed with PLSGraph is more reliable and stronger than the model build with Lisrel.

6 Final conclusions and remarks

First of all, we succeeded in building a model of BSC for the MSE and giving it a theoretical framework through the use of a rigorous and scientific methodology. Thanks to the PLSGraph software, we could test the relations of causality between the three prospects. However, we must moderate the results obtained for the link obtained between the “organizational” perspective and the “satisfaction” perspective, because the indicators selected for the “satisfaction” perspective proved to be weak estimators. Initially, these results indicate us that the financial resources of the organization are pre required for the development of competences of the employees, the improvement of structures and permanent research of the patients’ comfort. This makes it possible in purpose to guarantee the satisfaction of the customers, which coincides with the strategy of the MSE. Finally, we estimate that the hypothesis assumption is validated.
The objective of our work was to put in perspective the Balanced Scorecard in the debate between American pragmatism and a more theoretical European design. We built a strategic chart for a Medico-Social Establishment. We then tested the robustness of this model through the analysis of the links’ validity between the perspectives. With this intention, we used the PLSGraph software. The results obtained showed us that the reasoning of Balanced Scorecard postulated in the problems can be formalized in a rigorous way. We then have compared our results with results obtained in Lisrel and noticed that PLS in more powerful than CBM. We can moderate the remarks advanced by Kaplan and Norton as we showed in the analysis of the case. In our illustration, we arrived, using the PLSGraph software, to pose a theoretical framework for a pragmatic approach. It should be stressed that the conditions necessary to arrive here were relatively constraining. In general, it is necessary to have a sufficient number of indicators being used for estimating each perspective while respecting postulates such as normality or removing the strong correlation between the indicators. Then, it is essential to have a relatively important sample of data. Indeed, the amount of data could be a lot smaller than in the case of CBM. Even so, it appears difficult that this method would be used within the organizations. Moreover, the noted real use of Balanced Scorecard lies more in the diffusion and the comprehension of the strategy on all the levels of the organization. To conclude, we think that it would be relevant to develop a tool making it possible to formalize and to validate the strategy in a theoretical way, while using a simplified model. The PLS method suffers form a lack of theoretical base. Kaplan and Norton's approach was strongly criticized in the literature for this point of view. The difficulty with which the researchers will be confronted lies in the reconciliation between the pragmatism sought by the organizations and the need for the theoretical framework.
References


44. Virtual Computational Chemistry Laboratory - Partial Least Squares Regression (PLSR): http://146.107.217.178/lab/pls/