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# A model of integration among prediction tools: applied study to road freight transportation

## *Um modelo de integração entre ferramentas de previsão: estudo aplicado ao transporte rodoviário de cargas*

## *Un modelo de integración de herramientas de predicción: estudio aplicado al transporte de carga por carretera*

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**Abstract**

This study has developed a scenery analysis model which has integrated decision-making tools on investments: prospective scenarios (Grumbach Method) and systems dynamics (hard modeling), with the innovated multivariate analysis of experts. It was designed through analysis and simulation scenarios and showed which are the most striking events in the study object as well as highlighted the actions could redirect the future of the analyzed system. Moreover, predictions are likely to be developed through the generated scenarios. The model has been validated empirically with road freight transport data from state of Rio Grande do Sul, Brazil. The results showed that the model contributes to the analysis of investment because it identifies probabilities of events that impact on decision making, and identifies priorities for action, reducing uncertainties in the future. Moreover, it allows an interdisciplinary discussion that correlates different areas of knowledge, fundamental when you wish more consistency in creating scenarios.



*Keywords:* Decisions on investment; Scenarios analysis; Prediction model; Road freight transportation

**Resumo**

Neste estudo, buscou-se desenvolver um modelo de análise de cenários que integrou ferramentas para apoio à tomada de decisão nos investimentos: Cenários prospectivos (Método Grumbach) e Dinâmica de sistemas (modelagem hard), com a inovação da introdução da análise multivariada pelos peritos. A contribuição do modelo é a maior objetividade e clareza na análise que se dá através de simulação de cenários, com identificação dos eventos e das ações redirecionadoras mais impactantes, num sistema interativo em que novas previsões são possíveis de serem desenvolvidas através dos cenários gerados. O modelo foi validado no setor de transporte rodoviário de cargas do estado do Rio Grande do Sul. Os resultados mostraram que o modelo contribui para a análise de investimentos, pois identifica probabilidades de acontecimentos que interferem na tomada de

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decisão, bem como identifica prioridades de ações para a redução de incertezas no futuro. Além do mais, permite uma discussão interdisciplinar que correlaciona diferentes áreas do conhecimento, fundamental quando se deseja maior consistência na construção de cenários.


*Palavras-chave:* Decisão sobre investimentos; Análise de cenários; Modelo de Previsão; Transporte Rodoviário de Cargas

**Resumen**

En este estudio se busca desarrollar un modelo de análisis en que se integran herramientas de apoyo a la toma de decisiones de inversiones: escenarios prospectivos (método Grumbach) y dinámica de sistemas (*hard modelling*), mediante la innovación del análisis multivariado realizado por los expertos. El modelo contribuye con una mayor objetividad y precisión en el análisis y permite identificar los eventos y acciones más efectivos, en un sistema interactivo en que nuevas predicciones pueden desarrollarse por medio de la simulación de escenarios. Se ha validado el modelo en el sector de transporte de carga por carretera del estado de Rio Grande do Sul. Los resultados demuestran que el modelo contribuye al análisis de inversión, pues identifica probabilidades de eventos que interfieren en la toma de decisiones, así como indica prioridades de acciones para reducir incertidumbres en el futuro. Además, permite un debate interdisciplinario que correlaciona diferentes áreas del conocimiento, lo que es fundamental cuando se desea una mayor coherencia en la creación de escenarios.


*Palabras clave:* Decisión de inversiones; análisis de escenarios; Modelo de predicción; Transporte de carga por carretera

## Introduction

Prediction models are widely used in both business and public sectors. They are useful either for planning as for sensitivity analysis, as to the environmental changes for effective decision making. Thus there is a constant search to improve these models, so that errors and risks of the decision makers are minimized. This study includes some gaps since it works both in the prospection of opportunities as in the simulation, fundamental characteristics when analyzing investments influenced by a number of risks and uncertainties, which need to systematize a logical process to a wider range of analysis. These are not usual characteristics in the literature and the resulted model established a reflection on the integration of approaches on two tools: one that analyzes the variables under the static point of view (Prospective Scenarios) and another under the dynamic (System Dynamics).

Integrated models had provided superior results when tested for a given decision-making. Example is the model proposed by Mattos et al. (2008), which integrated econometric tools for time series with input-output models and brought contribution because it has established investment opportunities according to the configuration of each elaborated scenario. Nishikawa (2014) also proposed an integrative model to determine the behavior of financial defaults composed of macroeconomic variables and their correlations with a macroeconomic event, such as an economic crisis.

Specifically for sectorial scenarios for decision support with participation of experts, the model proposed by Blois and Souza (2008) integrated prospective scenarios to the dynamic systems, providing a qualitative description of the phenomenon and quantitative developments. This study has the incorporation of experts differential, which is not so widespread in the literature, with a convenience of allowing easy understanding and participation of experts in the construction and analysis of scenarios. This feature is important because it allows an interdisciplinary discussion that correlates different areas of knowledge, which is essential when you want more consistency in building scenarios.

In the present study, a change was proposed to the model developed by Blois and Souza (2008), incorporating the step "multivariate regression analysis" before performing the integration. The inclusion of this step can be considered a breakthrough since it enables the identification of correlations between variables for subsequent integration, thereby improving its consistency. Thus, this model will have as empirical field the freight transportation sector in the Regional Development Council (COREDE) Production, state of Rio Grande do Sul, Brazil, from 2016 to 2020.

The article is structured in four sessions. The first section, is where the study was contextualized and the problem and objectives were presented, the second section provides a brief review of the literature. The third describes the methodological choices. Then, the data was analyzed and discussed, so the model reaches the final format. Finally, we present the conclusions of this study.

## Literature review

The proposed model will imply integrating the tools of prospective scenarios and system dynamics. Therefore, both theoretical and literature reviews are supported by these references.

### *Prospective scenarios as a decision support tool*

Schwartz (2000) considers scenario as a tool to organize perceptions of future environments in which today's decisions will be based, which means they are "future stories" that can help in recognizing the changing aspects of the environment and assist in adaptation to them. The main objective of this process is to establish strategies that are compatible with all possible future events, since regardless of what happens in the future,



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