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DEMAND FORECAST AT THE FOODSTUFF RETAIL SEGMENT: A STRATEGIC SUSTAINABILITY TOOL AT A SMALL-SIZED BRAZILIAN COMPANY

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ABSTRACT

Demand forecasting plays an increasingly relevant role within competitive and globalized marketplaces, in as much as operations planning and subsequent transition into a sustainable chain of supplies, is concerned. To this effect, the purpose of this study is to present the application of demand forecasting as a strategic sustainability tool at a Brazilian SME. Therefore, this is a descriptive, *ex-post facto* and cross-cut, sectional time case study, which employs qualitative and historical quantitative and direct observational data and that utilizes, as both indicators of the level of service offered to consumers and of opportunity costs the

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artificial neural networks model and fill-rates, for demand forecasting and response purposes. The study further established cause-effect relationships between prediction accuracy, demand responsiveness and process-resulting economic, environmental and social performances. Findings additionally concurred with both widely acknowledged sustainability concepts - NRBV (Natural-Resource-Based View) and 3BL (Triple Bottom Line) - by demonstrating that demand forecasts ensure the efficient use of resources, improvements in customer responsiveness and also mitigate supply chain stock out and overstock losses. Further to the mentioned economic benefit, demand forecasting additionally reduced the amount of waste that arises from retail product shelf-life expiration, improving the addressing of demand itself and of customer satisfaction, thus driving consequent environmental and social gains.

Key-words: Demand forecasting. Sustainable supply chain. Sustainability

PREVISÃO DE DEMANDA NO VAREJO ALIMENTÍCIO COMO FERRAMENTA ESTRATÉGICA DE SUSTENTABILIDADE EM UMA PEQUENA EMPRESA BRASILEIRA

RESUMO

Em um mundo competitivo e globalizado, a previsão de demanda assume um importante papel para o planejamento das operações e em sua transição para uma cadeia de suprimentos sustentável. Nesse sentido, o objetivo do presente trabalho é descrever a previsão de demanda como uma ferramenta estratégica de sustentabilidade aplicável a uma PME brasileira. Portanto se trata de um estudo de caso descritivo, *ex-post facto* e de corte temporal seccional, que utiliza dados qualitativos, dados quantitativos históricos e observação direta sendo que, para predizer a demanda, o modelo de redes neurais artificiais e o *fill-rate* foram adotados como indicadores do nível de serviço oferecido ao consumidor, assim como do custo de oportunidade em resposta à mesma. O estudo também estabeleceu relação de causa e efeito entre a precisão da previsão, a responsividade da demanda e o desempenho econômico, ambiental e social decorrentes do processo. Em concordância com os amplamente reconhecidos conceitos da VBRN (Visão Baseada em Recursos Naturais) e 3BL (Linha Inferior Tripla), o estudo demonstrou que a previsão de demanda proporciona eficiência na utilização dos recursos, melhorias na responsividade do cliente e evita "perdas" por

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stock out e por *overstock* na cadeia de suprimentos. Além desse ganho econômico, a previsão de demanda reduz a quantidade de resíduos gerados pelo vencimento de produtos no varejo, melhora o atendimento da demanda e a satisfação do consumidor, com consequentes ganhos ambientais e sociais.

Palavras-chave: Previsão de demanda. Cadeia de suprimento sustentável. Sustentabilidade.

1 INTRODUCTION

Companies were driven by the many changes that, over the past few decades, Brazil experienced in both the economic and political spheres to seek offered product solutions which promoted profit generation, productive process efficiency and improved quality. In addition challenges of economic nature, in light of current restrictions as to the availability of non-renewable resources, companies were additionally shifted into a position whereby rethinking their future strategies became mandatory so as to ensure the sustainability of their very operation. Despite initial resistance to change, migrating to a sustainable supply chain condition became a core strategic competitive factor to ensure the continuation of the business in itself.

Academic research (Gupta & P-Desai, 2011) demonstrated that Sustainable Supply Chain Management (SSCM) promotes both efficiency and synergy between partners, supports the achieving of greater environmental performance, minimizes waste generation, engenders resource savings, improves the corporate image and promotes positive market exposure (Wu & Pagell, 2011). The collective knowledge this portion of existing literature suggests that sustainable organizational activities – whether upstream via suppliers or downstream, before customers – jointly enhance competitiveness and improve long-term environmental, economic and social performances (Vachon & Mao, 2008; Zylbersztajn & Lins, 2007; Gupta & P-Desai, 2011; Wu & Pagell, 2011; Zailani, Jeyaraman, Vengadasan & Premkumar, 2012).

Research on sustainability in Brazil and throughout the world most often pay special attention to empirical analysis conducted at large or open capital companies (Lemme, 2010). However, developing country economies – as is the case of Brazil – are mostly ground on small and average-sized companies (SMEs) and it would be quite a paradox to conclude that to these, there would not be an assortment of sustainability-relevant opportunities (Lee, 2008; Moore & Manring, 2009). SMEs play a vital role when it comes to managing limited environmental and social resources (Zorpas, 2010; Mazur, 2012) given that they account for almost 99% of the total number of companies across the globe and represent two thirds of job openings in their respective regions (Mazur, 2012). In Brazil, for instance, amongst the 6,1 million total number of companies, no less than 94% are deemed as being micro in size and 5,1% small-sized (Häner, 2011).

To pinpoint this study´s objective and evaluate demand forecasting as a strategic sustainability tool one might also apply to the Brazilian SME supply chain, this study used a selected portion of the study subject´s strategic map, as pictured in Figure 1. For common understanding´s sake, a strategic map is a given company´s strategy´s illustration, i.e., a visual representation of cause-effect relations between an organization´s key strategic components. As of the strategic map, one may visualize how

the various parts of a given company directly or indirectly contribute with its overall performance (Buytendijk, Hatch & Micheli, 2010). Figure 1 presents the strategic cross cut map that was used to illustrate the deployment of demand forecasting as a sustainability tool and to link its objectives to performance actions and measures. Furthermore, assessment of that which one poses to manage, grounds the reasoning for process changes (Epstein & Wisner, 2001).

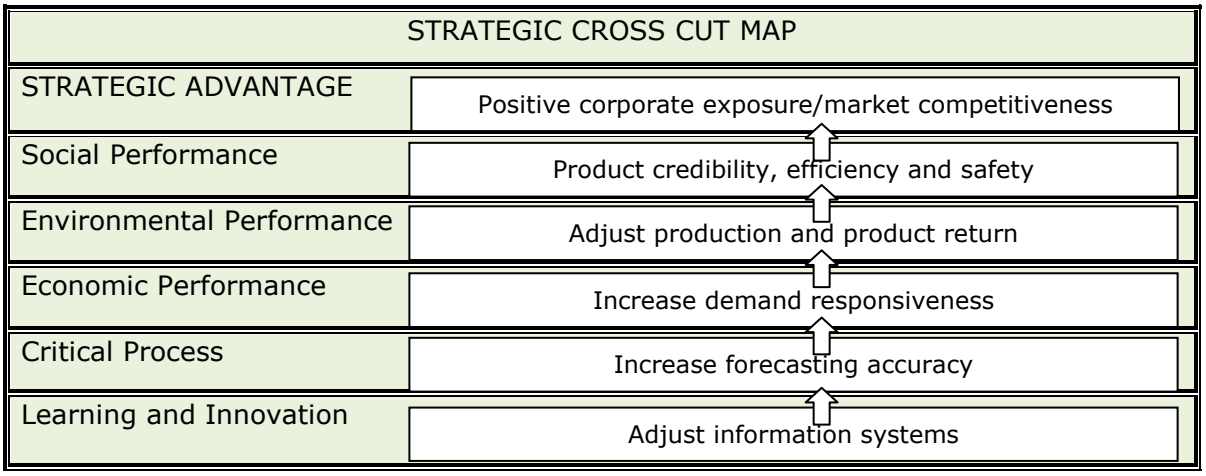

Figure 1: Demand forecast as a sustainability-ensuring tool employed at a Brazilian perishable foodstuff distribution SME

Source: Prepared by the authors

Figure 1 pictures the cause-effect relationship between forecasting accuracy, demand responsiveness and economic, environmental and social performance that results from the process. The illustration spotlights as key factor the chosen prediction method´s accuracy and emphasizes its core influence on corporate performance. Managers are able to evaluate if the company is achieving planned strategies as of the forecast´s accuracy measures, in addition to also being able to anticipate information, promote supply chain cost reductions and improve customer responsiveness (Veiga, Veiga & Duclós, 2010). Furthermore, whether in as much as supply chain is or not concerned, information preciseness impacts stock levels, waste volumes, addressing of demand and customer satisfaction (Sarkis, 2012), thus establishing a direct relationship with the company´s economic, environmental and social performance.

This study´s objective, in sum, is to describe a strategic sustainability tool as applied to a small-sized distributor of perishable foodstuffs: demand forecasting. As a result of operational activities, social, environmental and economic advantages shall also be herein presented. For demand prediction purposes, the influence of errors involving corporate performance forecasts shall be evaluated utilizing the fill-rate as indicator of the customer service levels and of opportunities costs once addressing the demand.

To meet the objectives herein set forth, this study was divided into five portions. Following this introduction, the required theoretical reference that grounds accuracy in demand forecasting as a strategic sustainability tool is discussed. Next, the study´s methodology, the analysis of results and finally, the study´s concluding findings are presented.

2 THEORETICAL REFERENCE

By the end of the XVIII$^{th.}$ Century, on one hand, the Industrial revolution coined a water shedding moment between human society´s interests, and on another, environmental preservation. XVIII$^{th.}$ and XIX$^{th.}$ Century´s understanding of business itself was ground on natural resources being inexhaustible. Within this framework, a given company´s competitive position was ensured by the heterogeneity and immobility of its strategic resources, characterized as being socially complex and of ambiguous causality, thus remaining valuable, rare, non-substitutable and barely imitable (Barney, 1991). Resources were deemed of value if either they were able to increase the customer´s motivation to purchase a given product or enabled less costly production. The "scarcity" attribute bestows the company with command over a premium product and hinders participation at perfectly competitive markets. Inimitability or difficulties involving equal imitation which most often derives from the resource´s social complexity, spruces the potential involving sustainable competitive advantages.

Thus, all in all, as of this Resource Based View (RBV), the corporate world systematically ignored the external factors surrounding the company´s environment, whether these featured restrictions imposed by the biophysical sphere (natural) or by challenges that arose from the social context (Hart, 1995).

Ever since the dawn of the 90´s, researchers found it quite obvious that both the availability of resources and of competitive advantages for corporate enjoyment purposes was bound to become increasingly limited with the passage of time. Changes of this kind have become far more visible particularly to those industrial segments where competitors have access to similar sets of raw materials and suppliers. By 1995, predictions already claimed that "In the future, strategy and competitive advantage will inevitably be ground on a company´s ability to develop environmentally sustainable economic activities" (Hart, 1995, p. 990). This context gave rise to the Natural-Resource-Based View (NRBV) which comprises mitigating pollution during product management and throughout a company´s sustainable development. Each of these pillars is founded on a set of different key resources and generates a distinct source of competitive advantage. Mitigating pollution in as much as reducing waste and pollutants is concerned, is linked to increased process efficiency and to the reduction of costs within the company´s supply chain.

Managing a product´s life cycle gives rise to competitive advantage that derives from strategic anticipation. Finally, sustainable development strategies seek alternative pathways which might be pursued in a continuous manner along times yet to come, yet in special focus on economic and social parameters.

Sustainable development is defined as a process whereby human development is conducted in an inclusive, connected, fair, cautious and safe society, focused on that deemed as qualitative in opposition to that quantitative. A sustainable entity is one which contributes with sustainable development by simultaneously generating economic, social and environmental benefits, a concept that has been widely acknowledged by the term triple bottom line or 3BL (Elkington, 1997). 3BL´s paradigm's core notion is that an organization´s end success can and must be measured not merely in terms of its traditional economic result, but also by its social-ethic and environmental performance. A sustainable organization is that which pursues profit and which at the same time, protects the environment and defends both collaborator and other stakeholder´s rights. In natural alignment, the mentioned social and environmental SSCM dimensions must be conducted under clear and explicit acknowledgement of the organization´s economic objectives.

Regardless of the notable differences that come to light in the correlation between environmental and economic performances, scientific studies on sustainability conducted in the field of Operations Management (Gupta & P-Desai, 2011) demonstrate that there is an immediate linkage between a company´s operational decisions and its environmental performance. Although environmental considerations give rise to additional costs and production system restrictions, they are also capable of generating new opportunities which, if duly explored, might drive improved economic performance and at the same time, mitigate existing negativity in the company´s environmental and social impacts. Corporate operational excellence promotes excellence in both environmental and competitive excellence (Gupta & P-Desai, 2011).

In terms of social initiatives, Brazilian SMEs are akin to infants when it comes to the development of sustainable operations impacting social performance, the underlying reason possibly being the fact that this parameter imparts less pressure that effectively enforces the implementation of changes (Lemme, 2010; Zorpas, 2010). Social programs improve corporate social reputation and indirectly increase sales yet most often, drive raises in production costs, particularly within a short-termist perspective (Zorpas, 2010). To this effect, the forthcoming couple of subsections of this study ground the use of accuracy in demand forecasting as an operational tool towards sustainability.

2.1 FORECAST ACCURACY AS A STRATEGIC SUSTAINABILITY TOOL

Within an industrial segment characterized by rapid and regular changes, companies are required to develop processes that ensure greater awareness as to future scenarios and possible outcomes to in turn enable their maintaining of sustainable competitive advantages (Teece, Pisano & Shuen, 1997). Demand predictions thus take on a prime role before the planning of sustainable operation within the chosen marketplace, whether from a macro or micro-economic standpoint. However, merely having a demand forecasting routine or system in place within the organization does not necessarily address end objectives. What truly ensures a given organization is capable of obtaining improved environmental economic and social performances is the quality of the information that routines and systems generate and thus offer as input to the process itself. Kuo and Xue (1999) clearly state that the key success factor, i.e., core point of attention, ensuring quality of decision processes is precisely the construction of an accurate demand forecast. Predictions attempt to calculate and foresee future events, conditions and contexts, offering the best possible assessment of commercial and available market information.

Demand forecast research has often presumed that accuracy is the prime criteria for one to select the ideal prediction model (Chu & Zhang, 2003; Terasvirta, Dijk & Medeiros, 2005; Pao, 2006; Coelho, Santos & Costa Jr, 2008; Veiga, Veiga & Duclós, 2010, Romualdo, Baptista & Vieira, 2010; Chen, 2011), despite multiple criteria being desirable when one effectively conducts in practice prediction techniques´ assessments (Yokum & Armstrong, 1995). Recent studies demonstrated that highly accurate demand forecasts take on a vital role in terms of retail profitability (Veiga, Veiga, Vieira & Tortato, 2012) and directly influence customer service levels, safety stock levels, total costs and supply chain performance. If a given forecast is more accurate, scholars understand that production may consequently better anticipate customer demand (Meijden, Nunen & Ramondt, 1994). Thus, inversely, inadequate predictions may jeopardize supply chain outcomes and give rise to three situations: stock-outs (non-addressing of demand), backlogs (demand addressed in arrears) and/or over-stock with products expiring validity deadlines at the point of sale. Situations of this kind, in addition to increasing product costs, pose risks to the very management of sustainable supply chains (SSCM).

Retail businesses often feature massive seasonal variation (Veiga, 2009). This is one of both retail´s and foodstuff industries´ greatest challenges: conduct production planning at an aligned pace with that of demand requirements. The prediction of seasonal data and trends has historically proven to be one of the most relevant efforts involving stock management research and, to this effect, a number of theoretical and heuristic methods have emerged over the last decades (Chu & Zhang, 2003). Traditional quantitative approaches include heuristic methods such as the decomposition of temporal series, exponential smoothing and autoregressive integrated moving averages (ARIMA). The most relevant restriction posed by traditional methods of the kind rests in the fact

that they are primarily of linear nature (Chen, 2011). When it comes to linear methods, most often users do not need to be acquainted with the complex relationship that embeds data. From a practical standpoint however, these methods do offer the benefit of being particularly friendly when it comes to both interpretation and implementation (Chu & Zhang, 2003; Chen, 2011).

The most common alternative employed when linear methods fail to address prediction process expectations is the taking into account of more complex, non-linear models (Chu & Zhang, 2003; Chen, 2011). Thus, many demand forecasting studies apply to regressions, non-linear methods such as Artificial Neural Networks (ANNs), the "*Fuzzy* System" and Support Vector Machines (*SVMs*) (Levis & Papageorgiou, 2005). Methods of the kind are coined to capture temporal series non-linear patterns. This is why they usually offer superior performance when modelling economic behaviours and when used to support more complex, underlying decision making processes. A recent investigative study in the field of foodstuffs demonstrated that the Neural Networks models effectively presents superior accuracy at times of determining demand forecasts (Angelo, Zwicker, Fouto & Luppe 2011; Veiga et al., 2012)

Measuring costs generated by forecasting mistakes is by no means an easy task (Veiga, 2009), whilst the same holds true as to finding on the marketplace, a model that adequately assimilates the peculiarities of each company´s operations. Therefore, once facing alternative and distinct prediction method possibilities, one must resort to performance indicators to identify which methodology best fits each given case. Although a number of comparative studies siding different demand prediction methods have been undertaken and reported in existing literature, findings do not reveal the existence of a consensus, but rather, conclusions are contradictory (Chu & Zhang, 2003; Xie, Lee & Zhao, 2004).

Furthermore, several studies compare diverse prediction models but do not investigate the use of information obtained in either decision making processes (Acar & Gardner, 2012) or their economic, environmental and social impacts on the supply chain as a whole. Amongst the handful of studies that do effectively address this theme, some demonstrate that prediction mistakes do impart significant impacts on total costs, on production scheduling and on rendered service levels (Xie, Lee & Zhao, 2004; Veiga et al., 2012) whilst others present entirely opposite results (Price & Sharp, 1985; Coelho, Santos & Costa Jr., 2008).

3 RESEARCH METHODOLOGY

Following a descriptive case study format and employing an *ex-post facto* and cross-cut temporal approach, research herein sought to analyse a true some circumstance to gather detailed knowledge of the chosen issue matter (Yin, 1987) and improve comprehension as to how SMEs may face the challenge posed by sustainable growth. To this effect, qualitative data, historical quantitative data and direct observation findings were employed, combining different methods to ensure triangulation (Voss, Tsikriktsis & Frohlich, 2002). The next sections describe the study´s subject company and the methodology employed to address the proposed objectives.

3.1 STUDIED CASE COMPANY

Indirect distribution is of vital strategic importance to companies producing perishable and low unit cost foodstuffs. This approach ensures the producing organization benefits with the transfer of costs to chain member intermediate entities who are able to address the entire small-sized retail niche, regardless of extensive geographical dispersion and small-sized average orders (Dias, 1993). Distributors in turn are safeguarded by clear and objective commercial contracts which specifically define the borderlines of regions they are held accountable for.

The organization that was chosen as subject for the purpose of this study in started up in 1995 as an authorized distributor of perishable foodstuffs. Its current sales structure covers an active registered database of approximately 2.500 clients, comprising supermarkets, grocery stores, bakeries and convenience stores. In as much as human resources is concerned, the company counts on 1 manager, 2 supervisors, 11 sales promoters, 15 sales persons, 15 drivers, 3 administrative assistants, 1 financial analyst, 1 invoice clerk and 3 stockers. The studied company is responsible for the distribution of the entire mix of perishable foodstuff product range within the region it operates – comprising a geographical area of 435 km^2 and approximately 1.800.000 inhabitants – where it deploys the contract on an exclusive basis at clients that have at each premise, a maximum number of 10 checkout points.

The company´s sales department is responsible for forecasting the demand. This company employs moving averages in conjunction with valuation that uses quantitative analysis which in turn may vary according to market manoeuvres. This model solely resorts to electronic Microsoft Excel software worksheets. Calculations are usually conducted on a weekly basis using historical data to compose the month´s predictions. Demand´s peak and averages registered over the preceding four week period, is evaluated. This analysis also takes into account an arithmetic mean between the weeks that comprise the month in course to prepare the following month´s forecast. The prediction analyst also factors in average and maximum demand figures during the

period and conducts required changes according to the company´s objectives and interests.

3.2 DEMAND FORECAST AS A STRATEGIC SUSTAINABILITY TOOL

Historical data comprising the period from 2009 to 2012 was collected to support the analysis of the demand forecast. This period was selected given the need to analyse a temporal series. Similar products were grouped and jointly analysed to both facilitate analysis and enhance the procedure´s managerial relevance. Given that the appropriate degree of product grouping depends on the decision making process that predictions expect to address (Zotteri, Kalchschmidt & Caniato, 2005), grouping criteria were established based on intrinsic product characteristics, gathering taking into account similarity traits.

Once data was compiled, five product groups were formed. However, this study chose to focus analysis on one single group that represented 70% of the company´s total sales and comprised a sum total of 59 SKUs (Stock Keeping Units). As previously mentioned, quantitative data refers to a specific geographic region, yet covers a set of clients selected for having remained void of changes during the studied period.

Findings encountered by a previous study conducted with the same product group undergoing analysis demonstrated that feed-forward neural networks trained employing the Levenberg-Marquadt algorithm result in the most accurate demand forecasting model (Veiga, Veiga & Duclós, 2009, Veiga et al., 2012). Given this evidence, choice fell upon applying both this prediction method and the model used by the organization on the historical temporal series subject to analysis, comparing results with those collected as being true demand figures so as to assess the accuracy of each methodology.

MATLAB´s ® 2011 software was used to implement information system model estimate routines to ensure the application of artificial neural networks (Haykin, 2001). An ANNs' (artificial neural network) ability to generate forecasts pertaining to a given temporal series or in identifying patterns within a set of data derives from its ability to learn from the environment in which it is embedded (Haykin, 2001). However, the issue involving learning is to, via an interactive – each entry triggering a response – and iterative (reiterated) process, find a set of free parameters that make the desired network performance feasible. Figures 4 and 5 illustrate the best network configuration process and the training and validation of the same.

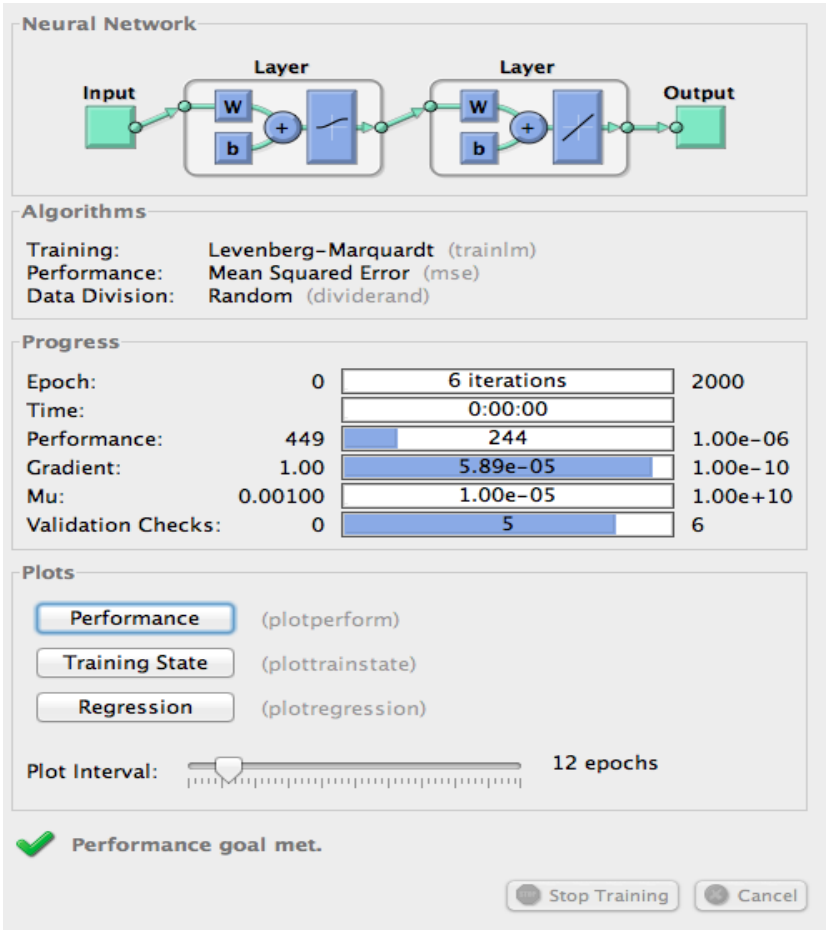

Figure 4: Best ANN configuration per MAPE accuracy measure

Source: Prepared by the authors employing MATLAB® 2011 software

The preceding 2, 3, 4, 5, 6, 12, 24 and 48 month series were selected to conduct ANN-based demand forecasts, following a logical discard of the poorest outcomes. A new analysis was established for each experience or epoch so as to obtain the best configuration by means of tests conducted on different amounts of intermediate layer neurons. Figure 5 pictures how model adequacy before data was evaluated, resorting to the analysis of residues, a parameter that was likewise employed to select the best network. As far as the products of the applied temporal series are concerned, five neurons and eight preceding months were taken into account. This configuration was selected based on *MAPE´*s (Mean Absolute Percentage Error) result.

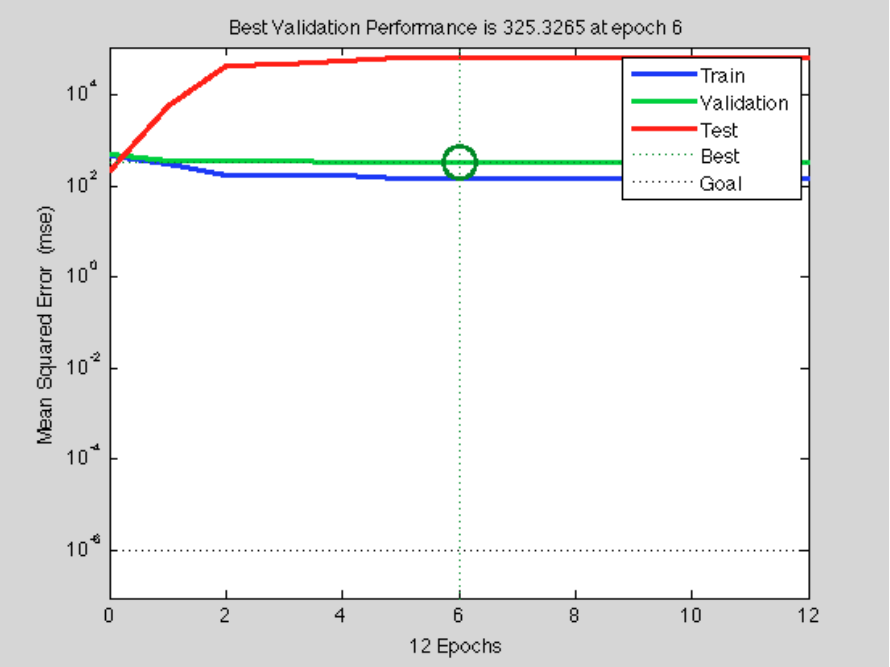

Figure 5: Best ANN prediction network training and validation

Source: Prepared by the authors employing MATLAB® 2011 software

The ANN and demand forecast accuracy group of selected parameters were measured according to the difference between period *t* prediction and the effective or actual *t* period demand (Chopra & Meindl, 2003). As per other scientific studies (Swanson & White, 1997; Chu & Zhang, 2003; Pao, 2006; Chen, 2011), accuracy and selection of ANN parameters were operationally calculated based on the smallest *MAPE,* mathematically represented by Equation 1, namely:

$$MAPE_n = \frac{\sum_{t=1}^{n} \left|\frac{E_t}{D_t}\right| 100}{n}. \qquad \textbf{(1)}$$

$|E_t|$ = absolute error figure during period *t*;
$|D_t|$ = absolute effective (actual) demand figure during period *t*;
n = all periods

The second stage employed the responsiveness index as indicative of customer service levels in addition to opportunity costs before the demand. Demand addressing responsiveness may be defined as the percent of demand that is directly met at the point of sale during a replenishing cycle (Zeng, 2000). The demand addressing index is all known as *fill-rate* (FR) and was calculated as demonstrated in Equation 2, below:

$$\text{FR} = 1 - \frac{\text{número de } stockouts \text{ esperados por ciclo}}{\text{número de unidades exigidas por ciclo}}. \qquad (2)$$

Finally, the third stage analysed the environmental and economic performance obtained by employing the greater accuracy forecasting model. Economic performance depends on the difference between possible incomes and costs (Lima, 2003). Thus, in this study economic performance was measured in terms of the fill-rate´s opportunity cost, mathematically expressed according to Equation 3, below. Both environmental and social performances were analysed from a qualitative standpoint, taking the causal relationship described in the strategic map cross pictured in Figure 1.

$$FR = 1 - \frac{\alpha G_{\mu}(K)}{Q} \quad (3)$$

μ = average;
α = standard deviation;
K = safety factor;
$\alpha G_{\mu}(K)$ = function of a lost standard unit (*stockout*);
Q = quantitative order

4 ANALYSIS OF RESULTS

The analysis of outcomes was subdivided into two subsections so as to address the objectives herein proposed. For starters, results involving the accuracy of demand forecasts as a strategic tool towards sustainability are presented. This study approaches social performance in as much as consumer and client servicing is concerned given that this attribute comprises the set sustainable companies need to address so as to improve product and services credibility, efficiency and safety. Subsequently, causal qualitative relations between the economic, environmental and social performances are described.

4.1 ECONOMIC PERFORMANCE

Figure 2 illustrates the graphic representation of results obtained as of applying prediction models to historical sales volume data extracted from August 2009 to August 2012. Forecast adjustments were made to the period comprised by August 2009 to August 2011 so as to project demand predictions for the period comprised between September 2011 and August 2012.

The actual demand between September 2011 and August 2012 totalled 1.339,55 tons; that forecast by the company totalled 1.215,67 tons and this study´s ANN findings, forecast 1.287,52 tons.

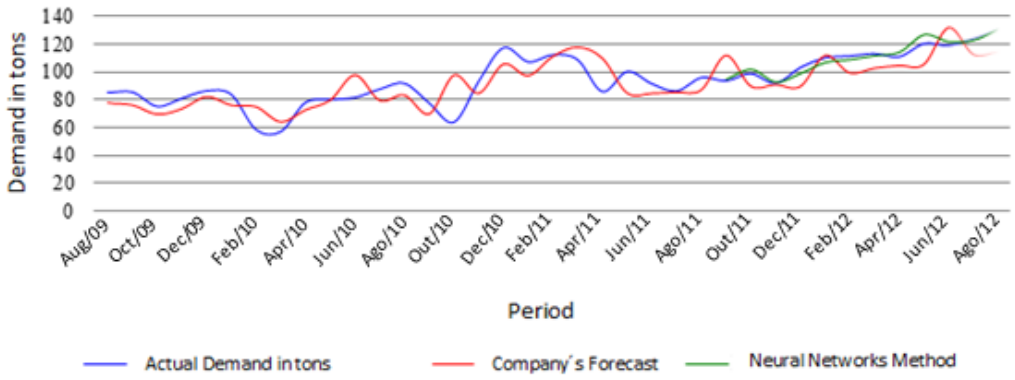

Figure 2: Comparison between the actual demand and results obtained by applying the prediction model utilized by the company and that of feed-forward ANN training using Levenberg-Marquadt´s algorithm

Source: Research data

As of Table 1, one notices that the prediction model that the company adopted resulted in a 90,75 % fill-rate (FR) or demand meeting rate. Once applying the ANN model and taking into account regular market conditions., predictions indicate that service or fulfilment levels would rather have reached approximately 96,12%.

Table 1: Fill-rate analysis considering the company´s forecasting model and that of ANN, as compared to actual demand figures

Actual Demand (t)	**Company´s Forecast**						**ANN Forecast**				
Tons	Tons	Error (t)	*Fill-rate %*	R$ Value per kg	Loss in Revenues	*MAPE*	Tons	Error (t)	*Fill-rate %*	Loss in Revenues	*MAPE*
1.339,52	**1.215,67**	**123,85**	**90,75**	**6,51**	**806,263**	**9,03**	**1.287,52**	**52**	**96,12**	**338,52**	**7,38**

Source: Prepared by the authors as of research data

Table 1 also pictures the influence demand forecast errors impose on the company´s economic performance as a whole. In as much as the group of products

analysed is concerned, the company failed to supply 123,85 tons to the market. If one takes the average R$6,51/kg product price, the demand forecast error corresponds to an approximate loss in revenues that amount to R$ 806.263,50 per annum.

On the other hand, if one employs the ANN forecasting model, an approximately superior R$467.740,00 annual economic performance, during the total period analysed might have been attained, at the studied company. This figure represents the difference between income losses when comparing the two analysed models.

An accurate demand forecast promotes efficient use of resources, improvements in client responsiveness and reductions of losses caused by over-stock and stock-out within the company´s supply chain. This strategic sustainability tool improves the addressing of demand with consequent gains in both environmental and social aspects, as detailed in the subsection that follows.

4.2 SOCIAL AND ENVIRONMENTAL PERFORMANCE

In as much as the environmental and social context is concerned, highly accurate forecasting systems are tools that enable the meeting of demand with the highest possible service level and at the lowest possible inventory cost. Most often, retail purchases small quantities of a small range of products, resulting in loss in both sales and profit margins, and quantities of a number of other items, leading to excessive inventories. Given this framework, forecasts attempt to calculate and predict a future circumstance by furnishing the best commercial information assessment, in other words, enabling client responsiveness increases, without binding the company to significant returns on products that do not sell or expire at the point of sale´s shelf.

From a social context standpoint, highly accurate demand forecasting increases the credibility, efficiency and safety of products offered to the market. This tool mitigates over-stock and its consequences, namely: (i) expired products remaining on the shelf because of retail carelessness and the (ii) depreciation of the brand name given that a parallel market of similar products emerges given the proximity of the shelf life expiration date. To this same effect, demand forecasting as a strategic sustainability tool can mitigate the substitution of a given brand name at the point of sale, whether driven by safety as to the quality of the offered product, or by avoiding stock-outs or non-addressing of demand itself.

From an environmental standpoint, a highly accurate demand forecast reduces the generation of solid waste which in turn is associated with the prevention and control of risks and damages to both human health and the environment. In light of the current restrictions as to the availability of non-renewable resources and limitations as to the final disposal of waste, reducing the generation of solid waste represents an important indicator of sustainable development. Furthermore, solid waste is an economic issue that

permeates all elements of the supply chain since it ruptures operations and generates distress that arises from the reverse flow of products.

At the foodstuff retail segment, the supplier (industry/distributor) is held accountable for managing waste, indemnifying retail with restitution in the form of identical products with a new shelf life expiration date or payment of a return invoice. In turn, the returned product can be disposed of in a number of alternative ways, from resorting to landfills to closed incineration.

In general terms one may affirm that the solid waste management process represents a cost for suppliers, whether due to the values of indemnifications involving expenditures to eliminate the expired product and the opportunity cost of non-sold returned products, or even due to its complete rupture at the retail end. A highly accurate forecasting system generates operational excellence at the organization, which in turn promotes excellence in its environmental performance and competitiveness.

5 FINAL CONDIDERATIONS

This study´s purpose was to analyse demand forecasting as a strategic sustainability tool as applied to a Brazilian SME, simultaneously describing the social, environmental and economic advantages that derive from the implementation of this process. The results herein obtained demonstrated that corporate economic performance is impacted by environmental performance via diverse routes. When an organization increases demand prediction accuracy and responsiveness, waste generation is mitigated and operational costs are reduced. To this effect, economic performance is obtained via the possibility of addressing demand at optimized service levels and minimum inventory costs. When the company´s environmental performance increases, it acquires a market advantage, which in turn generates increased revenues and unveils new growth opportunities.

To date, in as much as SME´s are concerned, the social component of the 3BL has been scarcely researched since most companies of this segment deem that socially responsible actions promote increased costs, particularly from a short-term standpoint. Precisely ground on this perspective, this study evaluated the subject company´s social performance solely within a qualitative analysis framework and by means of causal correlations with the other parameters sheltered by this investigation.

All in all, this study demonstrated that demand forecasting lies within the NRBV/3BL concepts given it serves as a tool to anticipate strategy which focuses on social, environmental and economic parameters. Demand forecasting promotes efficiency

in the use of resources, improves customer responsiveness and mitigates "loss" in the supply chain, stemming from stock-out and over-stock.

In addition to outcomes involving the economic advantage, demand forecasting reduces the volume of waste generated by products expiring at the retail front and improves the addressing of demand, with consequent environmental and social gains. Given that the tool is customized and depends on the product, on the company and on intrinsic market variations, anticipating information regarding demand and the company´s productive needs shapes relevant competitive advantages.

Setbacks include the fact that the new demand forecasting model calls for investments in the acquisition of software, collaborator training and maintenance. Under this scenario, the company will have to analyse if the migration to the prediction system is financially feasible. The system not only proves to be feasible once foodstuff market characteristics (high seasonality and frequent use of promotional activities), product characteristics (high perishability and short life cycle) and process characteristics (high lead time requirements and productive capacity restrictions) but also necessary to a foodstuff distribution company´s strategic and competitive planning.

In as much as the employed forecast method is concerned, research conducted within the Brazilian retail segment demonstrate that Neural Networks can predict product sales in the short term with greater accuracy than naive non-adjusted techniques and linear regressions which are, in effect, the models most organizations resort to (Almeida & Passari, 2006). Most commonly, Brazilian SMEs do not employ any method whatsoever to forecast demand and assess existing commercial information.

When SMEs do employ forecasting techniques, these most often are essentially incorporated into linear methodologies primarily in light of reduced cost, greater simplicity and the fact that they are practical and ease the process as a whole. Since these models hardly ever pinpoint the complex relations involving data, outcomes might prove to be unsatisfactory given the fact that they are not generated in a manner that safeguards an adequate level of accuracy.

Given the limitations of this study, new investigative research is deemed appropriate comprising managerial tools and demand forecast models based on Natural Computing (Castro, 2006) and which may be employed in management of sustainable supply chains (SSCM) highlighting applicability at Brazilian SMEs. Furthermore, future studies might involve sustainability relevant issues covering different dimensions, companies, segments and countries.

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