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Conclusion

The current thesis contributes to filling the gap in the literature regarding the lack of empirical multi-tier studies capable of investigating the inter-organizational components of SCF and SCRM, answering the research question "which are the main factors of flexibility and risk that affect the SC ability to deliver product to the end-customer?". Unlike other empirical studies that examine the theme of SCF and SCRM under the one-sided view of the company being researched or from dyads, this thesis is an effort to study connected systems aiming for representation of many tiers rather than a comprehensive picture of any one tier.

Concerning SCF, the research is intentionally restricted to focus on the flexibility types that matter end-customers (and their dimensional aspects) as a reaction to uncertainty in operational and tactical time-frame perspectives. To achieve this goal, the research embraces SCF types used to deliver external flexibility, such as sourcing, relationships, re-configuration, logistics and postponement flexibilities. As a result, the research data collection began downstream of the SC at dealers and OEMs' regional sales offices, identifying the main mix and volume flexibility restrictions for the SCs' end-customers. It is important to note that delivery flexibility issues are not addressed within the results of this study because end-customers in Brazil rarely buy built-to-order (BTO) vehicles. This reduces the relevance of the delivery time analysis for existing orders. This factor may change if this study is replicated in other auto-markets, such as the European market (mainly Germany), where BTO sales are common.

This thesis was not intended to exhaust all mix and volume flexibility restrictions. Rather, it identifies the main restrictions evident in the interviews and *in loco* visits and then goes upstream of the SC to investigate SC limitations at various tiers that limit the SCs' ability to fulfill end-customers' needs. This fact

contributed to achieve the thesis' first goal "to exam the main restrictions at various tiers that limit the SCs' abilities to provide flexibility to the end-customers, offering an overview of existing flexibilities restrictions". Uncertainty regarding end-customers' demand and supply process breakdowns were the main factors influencing the volume and mix flexibility in the studied SCs. Restrictions were identified in different SC members, including tier-1 and tier-2 suppliers, which reinforces the academic literature in the need to extend the flexibility debate to include the SC. The main restrictions identified were related to capacity production, stock overload, supply disruption, volume supply and long order lead-times. These restrictions jeopardized SCs flexibility and significantly reduced their ability to meet the requirements of the end customers. The SCs presented different aspects of flexibility that highlighted or mitigated the effects of SC restrictions. In turn, some events identified in the research, such as supply process breakdowns and supply disruptions, highlight the growing need to manage risks in SCs and support the increasing interest in the subject.

The study also implicitly highlights some drawbacks of the practice of reducing the supplier base, which in recent decades has become frequent in the automotive industry, especially in the Brazilian case (Pires and Sacomano Neto, 2008; Scavarda et al., 2010). Thus, the dependence on a single supplier for a particular item can result in a major constraint to the flexibility of the SC as a whole. Avittathur and Swamidass (2007) report a similar constraint in India. Likewise, the absence of one type of flexibility in one member of the SC may negatively affect another type of flexibility downstream in the SC, limiting the overall SC's ability to demonstrate flexibility to its end-customers. For instance, the lack of relationship and sourcing flexibilities with OEMs' first- and second-tier suppliers may result in volume and mix restrictions to end-customers. Similarly, the presence of one flexibility type may improve the overall SC's ability to demonstrate flexibility to its end-customers: postponing part of the vehicle configuration downstream in the SC may improve the mix offered to end-customers. This reinforces the interdependence of the SC members highlighting the need to match / align customer flexibility to supplier flexibility, what is also pointed out in Avittathur & Swamidass (2007) and Hua et al. (2009).

Furthermore, the results highlight the importance of SCF to increase the SC's ability to change its overall production volume or its product mix. The

results reinforce volume flexibility as a way response to demand uncertainty, following the conclusions from Sánchez & Pérez (2005). However, this is not always correctly understood among the analyzed firms. Increasing flexibility is not the same as increasing the SC's overall production plants capacity to react to a demand increase, as noted in our findings. If the demand decreases, this production capacity will became idle and stock will fill the pipeline. This concern was raised in the interviews regarding SCs A and B and was the downfall of SC C. A flexible SC should be designed so it can increase or decrease its production level to adapt to the demand, what requires not only a firm flexibility level (e.g. internal manufacturing flexibility), but also a customer – supplier flexibility level. Our research findings point to SC members focused on the enhancement of flexibility at the firm level more than at the customer-supplier level. This corroborates Sánchez & Pérez (2005) findings in the Spanish Automotive Industry and reinforces the fact that companies might miss opportunities to improve competitiveness by underestimating customer-supplier flexibility capabilities. From the perspective of usage flexibility, the analyzed SCs have been reactive to uncertainty (although with low response), and none of the studied SCs used flexibility to proactively seize opportunities.

The results also call for additional research. The effective use of flexibility concurrently for both proactive and reactive purpose was already studied in the printed circuit board industry (Sawhney, 2006) and should be better understood in the Brazilian Automotive Industry context, as it can become a competitive advantage from a SCF perspective. Further research in this area is required. In addition to advancing the academic debate on flexibility at a SC level by investigating the under-researched inter-organizational dimension of flexibility, this research is particularly relevant to practitioners. With the increasing synchronization of SCs, bottlenecks in supplying operations can become serious constraints in delivering products to customers. Therefore, an understanding of how SCs can be designed to increase the overall level of flexibility and how factors within and between the individual SC partners may restrict this flexibility are crucial for SC managers across many industries.

It is also important to highlight that the result of the lack of flexibility to reach the customers' needs can be represented in a SC as manifested risks. The SCs managers need to understand the cause of the lack of flexibility to be able to

deal with it. Once the lack of flexibility is translated in to risks, the treatment become easier, as the SCRM systematizes the management of the risks.

Concerning SCRM, this thesis identifies the main risks along three Brazilian automotive SCs, achieving the thesis' second goal "to identify the main risks by investigating their manifestation in these SCs offering an initial risk profile for the Brazilian automotive industry". The risks were classified according to the two external flexibility types that emerged from the SCF empirical results: as volume mismatch between end customers' demand and dealers' supply of some vehicle models and as mix mismatch between the end customers' demand and the supply of some versions of vehicle models based on factory-fitted options. The analysis of the manifested risks along the SCs revealed different risk drivers, sources, consequences, and mitigation strategies and was an attempt to study SCs through connected systems, rather than individual companies or dyads. This multi-tier empirical approach helps to bridge the identified gap in the SCRM literature, as recently highlighted in Hachicha and Elmsalmi (2013).

The empirical findings from this study provide interesting insights to the SCRM field, which can be very useful to both academics and practitioners. The first insight evidences the fact that although the importance of SCRM was recognized by all of the companies analyzed in the study, there was a lack of preparedness either in terms of not identifying risk or in not having thought about pro-active risk-mitigation strategies, risk treatment, and risk assessment. Very little evidence of applied SCRM is revealed at the SC level, which corroborates the findings of different empirical studies conducted in different countries and industries (e.g., Jüttner, 2005; Blos et al., 2009; Thun & Hoenig, 2011; Lavastre et al., 2012). The research result also shreds light on the enlargement of risk analysis as to incorporate the state interference into the problem. Environmental risk sources as government policy uncertainties, in the current SCs analysis represented by economic reforms, changes in government regulations and trade restrictions, were not revealed in a similar studies conducted in developed countries as U.K. (Khan et al., 2008), Germany (Thun & Hoening, 2011) and France (Lavastre et al., 2012). Our findings corroborate Novaes (2000) where global industries in developing countries like Brazil must learn to successfully operate with environment uncertainties in global operations to be competitive and to survive. The literature offers approaches as real options that can yield more

realistic and sound solutions for the problem (e.g., Cohen & Huchzermeier, 1999; Novaes & Souza, 2005; Cucchiella & Gastaldi, 2006), but the extension of their use to a multi-tier study embracing different connected firms within a developing country context is recommended for future research.

In addition to advancing the academic debate on SCRM, this research is particularly relevant to practitioners, as the investigation results also provides a basis for promote an initial risk profile for the Brazilian automotive industry to help this industry initiate the SCRM process. Because the risk identification phase is the trigger of this process, the provided initial risk profile can be viewed as a significant contribution. Moreover, the adopted methodology can provide guidance for practitioners in similar undertakings within different industries. Finally, it is also relevant to remark that longitudinal field and multi-tier studies such as the one presented are time-consuming research, what reinforces the contribution of this study, as similar studies are not easily replicable.

It is worth noting that although the case study was conducted on three relevant SCs of an emergent economy, the research approach provides evidence for a single industry and country, which limits the extent to which the findings can be generalized across a wider range of industries and countries. Because comparable studies in the literature are still lacking, this investigation is only an initial step towards the study of two SCM fields that are likely to grow in importance as competition has moved from individual firms to supply chains, increasing companies' dependency on supply chain members, and as companies continue to reduce their supplier base and outsource their activities, making them more dependent on their SC members, both upstream and downstream. In this sense, future research can be suggested concerning multi-tier studies in other industries and countries, beyond maturity models in SCRM and SCF, where companies can analyze their performance against best practices.