Understanding the influence of IT investment on supply chain governance (SCG)

Pietro Cunha Dolci  
University of Santa Cruz do Sul  
and FSPOA  
pedolci@unisc.br

Antônio C. G. Maçada  
Federal University of Rio Grande do Sul  
acgmacada@ufrgs.br

Gerald G. Grant  
Carleton University  
gerald.grant@carleton.ca

Abstract

The aim of this study is to analyze the influence of IT investments in supply chain governance (SCG) and its conceptions (contractual, relational and transactional). This study used qualitative and quantitative techniques to assist the researcher in obtaining a better and a more in depth understanding of the phenomenon. In the qualitative step, five items emerged that was applied to identify and measure the influence of IT investments on SCG: monitoring, products and orders tracking, information sharing, integration and cost reduction. All SCG elements were confirmed and validated by interviewees with the exception of the element cooperation and opportunism. Contracts were separated in informal/formal and opportunism was changed to transparency. In the quantitative step the model was validated and all hypotheses were confirmed. Thus, in this study we found a positive and significant influence of IT investments on SCG and its conceptions.

1. Introduction

According to Computerworld [10], worldwide investments in IT will grow 4.1% in 2013 and should reach 3.8 trillion dollars. This is especially the case for investments in database software, data integration and supply chains. Information technology is considered a critical success factor in supply chains nowadays [41]. Simchi-Levi and Fine [34] suggest IT’s importance in supply chains is increasing, as it will allow businesses to monitor, plan, implement and better adjust to the ever increasing market shifts, support expanded inter-organizational relations, and impact the supply chain.

For Zohar [46], IT is going through big changes and the Chief Information Officer must prepare for and learn advanced management methodologies applied in supply chain context. It is necessary to instantiate practices which balance the interests of enterprises and the individual decisions carried out by the decision makers, taking all supply chain partners into consideration. According to Senge et al. [33] one of the ways to face market shifts and demands is to design and institute a supply chain governance (SCG) arrangement. SCG in this study is a multidimensional phenomenon encompassing business structures and processes and considered as a means to analyze inter-organizational relations.

Singhal and Singhal [35] point out that studies in the 90’s established the supply chain as a prolific area for research enabling it to develop, combine, and integrate a variety of aspects, topics and frameworks. Daugherty [13] argues that the relationships among companies are dynamic and IT is particularly critical in helping with the supply chain’s strategic decisions.

Such concerns, as well as IT investments, have been increasing over the years, highlighting the growth and relevant expenditures on IT in supply chains. However, according to Li et al. [27] very few research efforts have focused on the outcome of such investments in supply chains and its governance. Several studies have examined IT in supply chain management [45], but few studies have looked at IT in relation to SCG [6, 17]. Thus, studies are needed to answer the questions: how IT investments influence SCG and which variables should be analyzed to understand this phenomenon? How could these investments help companies to better govern their supply chain?

In this research we aim to answer these questions by focusing on SCG and presenting the relevance of IT investments in supply chains. We analyze the influence of IT investments on SCG and its conceptions: contractual, relational and transactional governance. This study used qualitative and quantitative techniques to assist the researcher in obtaining a better and a more in depth understanding of the phenomenon.

2. Information Technology Investment

In recent years, network leaders such as Chrysler, Dell, Ford, and Wal-Mart have made significant efforts.
to derive the benefits of collaborative planning among supply chain partners through the sharing information with their suppliers and by investing in IT related to the supply chain [8, 40]. A close relationship between businesses results from trust, commitment, collaboration, qualification as a supplier, capacities, skills and abilities to use technology. This promotes survival of the enterprise, enabling increased competitive advantage [7].

IT has a support role in the relationship with buyers and suppliers, manufacturers and retailers, and retailers and buyers, benefiting all partners [13]. These different relationships are necessary because of globalization and also because of the increasing focus on outsourcing. It allows organizations to better evaluate the supply chain’s configurations and therefore better integrate businesses [2]. But this process was and still is complicated by geographical dispersion, considered a barrier for communication, collaboration and cooperation. As a result IT plays a fundamental role in supply chains and consequently in their governance.

Some technologies help to control a range of activities, allowing flexibility to adapt in response to changes faced by the business [1]. IT permits the processing of information in a more precise manner with more frequency and a higher amount from geographically dispersed sources. It enables speedier response and allows the continuous update of information. It also supports planning and forecasting. Daugherty [13] argues that such technologies have, as a common basis, information sharing among partners. The technologies make it possible to publish, store and make use of an abundance of information made possible through a sophisticated analytical system. Moreover, Subramani [40] pointed out that IT use was particularly important to the quality-control processes of companies in the supply chain.

IT also helps companies that are members of the supply chain to reduce the complexity of transactions because all information is standardized and relatively easy to understand [29]. Depending on the type of supply chain and product a more complex transaction may arise. EDI investments, for instance, generates coding patterns that should be negotiated and dealt with among companies in the supply chain. According to Akkermans et al. [1], some technology, such as ERP, through the structured information it generates, provides increased power for the company to control a wide range of activities (finance and inventory) as well as to control the shop floor. In addition, the use of incentives can reduce the misuse of these systems, for example, the use of phantom bids or unqualified providers [44].

Reducing opportunism between businesses is another important element for IT use in the supply chain. The implementation of internet-based technologies can minimize opportunism because it allows for more transparency in transactions amongst supply chain partners [19]. Since the 1990’s IT has been considered a tool for vertical integration within organizations. More recently an integrated supply chain involving customers and suppliers is achieved with the help of IT and systems [20].

According to Gereffi, Humphrey and Sturgeon [16] the key to global-scale industrial organization is the fact that coordination and control can be reached without direct involvement. As for Chong, Ooi and Sohal [9] IT tools, such as electronic collaboration can bring effective benefits by reducing transactional governance costs with external elements in comparison with internal coordination costs. These types of technology provide for a reduction of communication costs and may be used to enhance coordination within the supply chain [18]. Inter-organizational coordination, represented by IT communication dimensions, partnerships, and monitoring, positively affects logistics performance [39].

To Ghosh and Fedorowicz [17] a flow of information is necessary in each point of the supply chain, in real time, to facilitate coordination and achieve higher performances. Sharing specific information in real time enables better and more accurate planning [37]. Businesses should take advantage of IT to coordinate actions necessary to ensure punctuality in information supply and flow. To guarantee this coordination, companies must have governance in which information transparency within the supply chain enables the anticipation and sharing of risks among partners.

To ensure transparency in information flow, it is necessary to create patterns and consistency to guarantee everyone complies with all requirements [6]. Fawcett et al. [14] affirm that information sharing and partners’ interests, when aligned, are significant to achieving supply chain goals. The same authors point out that a lack of coordination occurs when decision makers have deficient information or incentives that are incompatible with planned goals.

### 3. SCG: theories, elements and conceptions

Although a significant part of governance literature gives special attention to control practices and role description in organizations, other theoretical approaches broaden the understanding of the governance concept [32]. Cornforth [11] suggests theoretical perspectives through which the governance concept can be viewed: agency theory, stewardship theory, transaction costs theory and resource dependence theory.
Since SCG is a relatively new topic [31], it is helpful to use different theories to explore the subject. Thus we used 4 theories to understand and group several elements related with SCG.

Agency theory postulates that companies in the supply chain have different interests; thus governance emerges as a set of practices to guarantee control and coordination of actions in the supply chain. Contracts are a way to provide guarantees to companies in the supply chain and allow for conformity on actions performed. Often, a way to achieve the supply chain’s business goals is through the provision of incentives. Power is also a crucial element in the supply chain and is important to guarantee control and performance of contractual arrangements in support of the business interests. We call the conception of governance, supported by agency theory, contractual governance.

With transaction cost theory the organization is seen as a governance structure serving as an instrument to minimize transaction costs. Different forms of organizations are offered that aim to minimize the effects of bounded rationality and safeguard transactions against brokers’ opportunism. Transaction costs are influenced and established according to the complexity and codification of each operation. We refer to the conceptions of governance suggested by Transaction Cost Theory as transactional governance.

With resource dependency theory organizations rely strongly on the external environment to survive, in particular with on other SC business’ partners. In this context, governance is a set of practices to develop a relationship with this environment to attain all resources and necessary information to ensure the organization’s survival. Therefore, the characteristics of suppliers (capacities, qualifications and flexibility) take on an important role in relation to SCG.

Lastly, stewardship theory supposes that different partners in the supply chain may be seen as allies with common interest. In order for this to happen, business partners in the supply chain must trust one another, cooperate, be integrated and committed, collaborating to achieve the supply chain’s goal. Both resource dependency theory and stewardship theory point to what we call relational governance. All theories, constructs and variables to measure SCG and definitions are presented on Table 1.

We can understand SCG as an institutional framework in which companies that are members of the supply chain are inserted, where there are relationships between these companies, where transactions are made and where companies use standards and contracts to relate and make transactions. SCG acts as an expanded view of the supply chain, focusing on more strategic and long term inter-organizational aspects.

### Table 1. Theories, Constructs, Variables and Definitions

<table>
<thead>
<tr>
<th>Theory</th>
<th>Const</th>
<th>Variable Definition</th>
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<tbody>
<tr>
<td>Agency theory</td>
<td>Contractual</td>
<td>Companies with different interests, thus governance emerges as a set of practices</td>
</tr>
<tr>
<td>Transaction cost theory</td>
<td>Transactional</td>
<td>Governance serving as an instrument to minimize transaction costs</td>
</tr>
<tr>
<td>Stewardship theory</td>
<td>Relational</td>
<td>Partners in the supply chain may be seen as allies with common interest</td>
</tr>
<tr>
<td>Resource dependency theory</td>
<td></td>
<td>Organizations rely strongly on the external environment to survive</td>
</tr>
</tbody>
</table>

### 4. Research model and hypotheses

We found only two studies that directly related IT and SCG. Bitran, Gurumurthi and Sam [6] argue that IT performs a directing role and it has also fostered fundamental transformations in supply chain behavior and governance. Ghosh and Fedorowicz [17] point out that IT is used for coordination and information sharing in the supply chain, relying on a cohesive set of communication processes which expand governance. Besides these, two studies [2, 16] relate the use of technology in general to supporting interaction within businesses and refer to aspects of SCG in relation to the use of standardization and common languages amongst the chain business partners. This leads to the first hypothesis of this study: Hypothesis 1. Investment in IT positively influences SCG.

Relationships between IT investments and contractual conceptions in the supply chain have been identified. According to Akkermans et al. [1] and Gereffi, Humphrey and Sturgeon [16] some technologies could be used to increase power for the company to control a wide range of activities, including the contracts among companies in the supply chain. Moreover, the use of incentives can reduce the misuse of systems [44]. Coordination was identified as an important aspect that IT investments could help to achieve [16, 17, 18]. Therefore, the second hypothesis of this study is: Hypothesis 2. Investment in IT positively influences contractual SCG.

IT investments also influence supply chain aspects such as, transaction costs, opportunism, codification and transactional complexity. According to Gunasekaran and Ngai [19] investments in some internet-based technologies can minimize opportunism allowing more transparency in transactions amongst
supply chain partners. IT investments help companies that are members of the supply chain to reduce the complexity of transactions [29] and transactional governance costs with external elements [9]. Moreover, IT creates patterns and codes to guarantee everyone in the supply chain comply with all requirements [6]. So we postulated a third hypothesis of this study: Hypothesis 3. Investment in IT positively influences transactional SCG.

Finally, IT investments play an important role in supply chains’ relationships benefiting all partners [13]. It supports building trust [4] among supply chain partners while fostering collaboration [40, 41], commitment, cooperation and integration [2, 7, 18]. It is also a relevant factor in identifying the characteristics of suppliers such as qualification, flexibility and capabilities [1, 7]. Consequently, the forth hypothesis of this study is: Hypothesis 4. Investments in IT positively influence relational SCG. Table 2 portrays this study’s hypotheses as well as their influence and the previous studies that support each hypothesis.

Table 2. Hypotheses, influence and references.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Infl. Authors</th>
</tr>
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<tbody>
<tr>
<td>1 IT Invest.-&gt;SCG</td>
<td>+</td>
</tr>
<tr>
<td>2 IT Invest.-&gt;contractual SCG</td>
<td>+</td>
</tr>
<tr>
<td>3 IT Invest.-&gt;transactional SCG</td>
<td>+</td>
</tr>
<tr>
<td>4 IT Invest.-&gt;relational SCG</td>
<td>+</td>
</tr>
</tbody>
</table>

5. Method

This study used qualitative (first step) and quantitative (second) techniques to assist the researcher in obtaining a better and a more in depth understanding of the phenomenon [12] aiming to identify the relationship between IT investments and SCG. The methods used included the analysis of multiple case studies [43] and a questionnaire survey [36].

The theoretical research in the previous step was used as the basis of the case study protocol, which is designed to guide the researcher when collecting data for a case study [43]. The protocol plays an important role in ensuring reliability, providing information so that the research, repeated under the same conditions, obtains the same results [43]. Thus, the protocol used in the case study was developed taking into account the elements of SCG and IT studied by the different authors mentioned in the literature review.

The data collection in the multiple case studies was derived from interviews with strategic level supply chain executives. We interviewed the top supply chain executive in each company. They were previously contacted and agreed to answer the questions. We made efforts to get top executives, excluding middle and low level. These were individuals that have significant experience and have been working in the supply chain area for many years. They also have knowledge of IT investments and their use in the supply chain. We conducted the research in two large companies from important sectors of the Brazilian economy (automotive and manufacturing industries), each with two major suppliers that are of clear importance to the company (Table 3). All interviews were recorded and transcribed. In this step, the interviews represented the main source for database research; thus content analysis is applied to examine the information obtained [5]. A thematic analysis was utilized in this study; which consists of figuring out the core values that set the communication; whose presence or appearance frequency can mean something for the analytical goal chosen.

Table 3. Companies and Respondents

<table>
<thead>
<tr>
<th>Supply Chain</th>
<th>Companies</th>
<th>Respondents (Working in SC / current company)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Automotive Supplier</td>
<td>Large Co 1</td>
<td>SC VP for America (3,5y/3,5y)</td>
<td>2 hr</td>
</tr>
<tr>
<td>2 Supplier</td>
<td>Large Co 4</td>
<td>SC Manager (11y/5y)</td>
<td>1.5 hrs</td>
</tr>
<tr>
<td>2 Manufacturing Supplier</td>
<td>Large Co 4</td>
<td>SC Manager (11y/5y)</td>
<td>1.5 hrs</td>
</tr>
<tr>
<td>2 Manufacturing Supplier</td>
<td>Sales Director (-)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The interviews lasted one hour and thirty minutes on average. Some characteristics of the respondents were taken into account, such as their length of time working with the supply chain, length of time at the current company and knowledge about the subject of the study. Another important feature of this research is that the companies all have a large and structured supply chain with hundreds of products and suppliers.

Categories were determined based on the (units’) core meanings, which were separated into three groups: final (four conceptions – contractual, relational and transactional – and IT investment in SCG), intermediate (SCG elements, conceptions and how IT is related and support) and initial (definitions, uses and examples), which are presented in each case separately.

Thus, from the literature review and the qualitative step of the research, an initial data collection instrument was generated with 23 items related to the constructs: IT investment (5 items), contractual SCG (6), relational SCG (8), and transactional SCG (4). After creating the research instrument, a pre-test was carried out before was sent to a larger sample.
The survey research instrument derived from the multiple case studies was then sent to potential respondents in large Brazilian companies. With this survey method [36], we sought to identify the influence of IT investments on SCG and its conceptions.

The sample of this study is drawn from large-sized companies and their suppliers that possess a wide and complex supply chain in Brazil, and that make use of different IT processes related to the SC actions. The sample frame included managers in strategic level positions, such as, vice-presidents, directors or functional area managers in supply chain, logistics, commercial, and operations, who hold a general view and had a deep understanding of the supply chain’s operation and the relationship with buyers and suppliers. The questionnaire was available and distributed to the companies using Internet based software. To increase response ratings we sent complementary information and a feedback e-mail.

For the development of the pre-test in the quantitative stage steps for instrument validation were utilized, as well as the following constructs proposals from Koufteros [24]: instrument development, data collection, verification of the preliminary and final instrument authenticity based upon the measurement of the Corrected Item-Total Correlation (CITC) and Reliability Analysis (Cronbach’s alpha). Yet, the uni-dimensionality test was carried out via Exploratory Factor Analysis on the block.

With the survey, the process of refinement and validation of the final instrument followed the stages proposed by Koufteros [24], and Koufteros, Babbar and Kaighobadi [25]. The data collected through the research instrument was organized and analyzed with the assistance of IBM SPSS software, using multiple forms and descriptive procedures. For the structural model a structural equation format was used with the help of IBM SPSS AMOS software. Once the models were identified, statistical techniques were put in place to evaluate the research hypothesis.

We applied statistical techniques to provide descriptions of the sample, measures of the instruments reliability, and validation of the research model.

6. Analysis of the Qualitative Research

From the analysis of the interview transcriptions in the Case Study 1 (Companies 1, 2 and 3) and Case Study 2 (Companies 4, 5 and 6) it was possible to identify that elements from IT investments are connected to SCG. It was also possible to highlight how such investments relate to each SCG conception.

The monitoring of pricing, quality and amount are related to SCG. Product and order tracking are possible through investments in technologies by the companies in the supply chain. Information sharing, the most referred to item by the interviewees, is a crucial element in the relationship between IT investments and SCG. Integration in the supply chain’s actions is also an important element identified by the companies as being relevant when analyzing SCG. And lastly, investments in IT can speed up commercial trades between the company and its partners, enabling reductions in company costs in such chain actions. Therefore, five items came up that can be utilized to identify and measure the influence of IT investments on SCG: monitoring, products and orders tracking, information sharing, integration and cost reduction.

Beyond that, it was possible to determine that different IT investments are performed to carry out the actions and processes of SCG. IT investments related to contractual SCG revolved around issues of standardization, compliance and monitoring with partners. They took into consideration suppliers contracts, and planned with reports in accordance with companies’ needs and demands. Investments in this conception helped with tracking supplier’s orders, visualizing the requests and requirements, and assisting in the control and coordination of actions and processes in the supply chain.

IT investments supporting Relational SCG are performed to increase essential and strategic information sharing regarding prices, cost forecast and company’s expectations. For example, providing an environment where companies develop mutual understanding, get to know each other’s needs, and help each other whenever necessary. Besides, they assist in the approximation and further integration among companies when it comes to their activities, processes, capacities and suppliers qualifications; allowing for a quick rebound in case of market shifts and also by helping in the development of new products and processes amongst the businesses.

IT investments related to Transactional SCG help reduce transaction costs through more efficient, faster and agile processes, with more information to avoid using companies’ resources in other activities that do not generate any value to the business and the chain. This cost reduction is achievable also by creating standardized transactions amongst the companies through a common language understood by all; and, assisting in cutting back complex information, making the access and understanding of this information easier.

All SCG elements were confirmed and validated by the interviewees in companies 1-6 with the exception of the element cooperation and opportunism, and new elements came up from the analysis. Contracts were separated into formal and informal, as according to the interviewees there are conditions and situations in...
which a formal contract is not enough to carry out an action. This finding is in accordance with Ferguson, Paulin and Bergeron [15] that highlight the role of informal contracts in inter-organizational relations. Different studies identified cooperation as a governance element in the supply chain [22]. However, there is neither consensus nor a definition about the element. Therefore, cooperation was not identified as a separate element in relational SCG, but yet, a close collaboration amongst companies was anticipated. This way, this item was eliminated from the model for being too close to the collaboration element.

The item opportunism was identified as being something negative and depreciative by the respondents, who believed in the possibility of this term to affect the interviewee’s answers and could change the understanding of this aspect. So, the respondents suggested altering the term opportunism to transparency in transaction amongst businesses in the chain. Therefore, to avoid misunderstandings over this element and its influence over the answers from the executives, it was altered to transparency. Based upon the considerations from the qualitative stage, the model used to carry out the quantitative stage comprises 4 constructs and 23 items. The next section presents the results found in the quantitative stage.

7. Analysis of the Quantitative Research

The pre-test, according to Malhotra [28], is the test of the preliminary research instrument in a small sample of interviewees, aiming to identify and eliminate potential problems and allowing for its improvement. Thus, the instrument derived from the qualitative stage was tested with 30 executives from large sized Brazilian companies. Following Koufteros [24] stages an analysis of the reliability (Cronbach’s alpha of constructs and the instrument; and CITC) and the exploratory convergent factor analysis were conducted to refine the preliminary instrument.

The ratings from the alpha of constructs and the instrument came above the 0.6 considered satisfactory for investigatory research [21]. Items with CITC below 0.3 were discarded as pointed out by Simson [38]. This way, the item “buyer and supplier informal contracts” was eliminated. In the exploratory convergent factor analysis, the method for determining factors chosen was the Analysis of Main Components, as it uses the total item variables; and the Varimax orthogonal rotation method. The only item that presented rating below recommended for exploratory studies (0.4) according to Hair et al. [21] was “Power in relationships”, which was withdrawn from the instrument. Therefore, the instrument utilized in the research has 4 constructs and 21 items.

The questionnaire was sent to executives from supply chain and logistics of the largest companies in Brazil and their suppliers. Moreover, executives were asked to send the contact information for or to forward the questionnaire to other executives in the same business areas from buyers and supplier’s companies. The questionnaires were sent to 400 executives, from large supply chain groups in Brazil that agreed to participate. We encouraged them to send the questionnaire to other executives from the same level or send to us the contact information of other professionals working in the same area and same level. After that, we sent three other reminders of the research. The first was sent out 15 days after the first remittance, the second a month later and the final one 45 days after the dispatch. In total 197 questionnaires were returned and 185 were considered valid.

The largest group of participants in the survey (57%) comprised executives occupying higher administrative positions. The 185 executives work in 121 different large sized companies from diverse and important Brazilian economic sectors. Most companies analyzed are from the automotive sector (19%) followed by electronics, and retailers. More than half (55%) employ over 500 workers. The respondents are employees from companies with a turnover between 100 and 500 million Reals (17%) or over a billion Reals (13%). It is relevant to mention, regarding IT investments in the supply chain, that there was a predominance of investments in ERP (140) followed by business portals (115), WMS (94) and EDI (94).

Keiser-Meyer-Olkin (KMO) sample adequacy tests and Bartlett’s test of sphericity presented acceptable ratings, respectively 0.889 and significance level 0,00 indicating the existence of important correlations between items. Besides, the instrument’s reliability was confirmed, as the constructs (0.7 - 0.91) and instrument (0.927) showed Cronbach’s alpha above 0.7. The final sample was 185 cases, considered adequate to the use of confirmatory factorial analysis based on structural equation modeling (SEM).

7.1 Measurement Model

The Measurement Model was validated by applying the AFC following the stages proposed by Koufteros [24]. Stages 1 and 2 instrument Development and Data Collection had been previously applied. After defining a model – respondent’s refinement, final sample adequacy test and reliability analysis – an initial measurement model is proposed. Throughout the third stage proposed the measurement model must run through specific software for SEM (AMOS 21), thus defining the measurement model with the constructs and respective items.
Convergent validity is the next step, that is, observation of the t ratings and the standardized factorial values. Ratings (t) must stay above |2| or |2.576| considered significant for levels 0.001 and the standardized factorial values over 0.5 seen as significant for levels 0.001. In all constructs values t were above the indicated ratings for significance 0.001 and standardized factorial values superior 0.5.

The 4th stage involved evaluating the adequacy of ratings and uni-dimensionality, standardized residual covariance and modification indexes were analyzed. According to Koufteros [24] standardized residual covariance ratings between the variables or items above |2.58| and modifying index higher than 12 deserve researchers’ attention. As for the analysis of standardized residual covariance ratings and the modification indexes, there were 5 variables identified presenting ratings above the reference values and they were discarded from the model. All items of the construct IT investments remained in the measurement model. With regards to the construct contractual SCG, the item incentives was withdrawn from the model for presenting a standardized residual covariance with items integration and capacities at 3.242 and 4.497, respectively. In the transactional governance items transparency was removed from the model for showing a standardized residual covariance rate of 3.395 with item relationship. In the relational governance construct the item commitment reported rating above the suggested with item trust and therefore eliminated. Moreover, item relationship presented high ratings of modification indexes (14.285) with item transparency, so, in the measurement model it was eliminated.

After eliminating these variables, a new factor analysis was carried out, using Analysis of Main Components and the Varimax orthogonal rotation method with 16 items and 4 constructs. All constructs presented acceptable values (0.4 – 0.93) and KMO 0.88 showing that this analysis is valid and the variables could be grouped (Table 4).

<table>
<thead>
<tr>
<th>Block</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
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<tbody>
<tr>
<td>T1</td>
<td>.785</td>
<td>.810</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>.778</td>
<td>.749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>.816</td>
<td>.715</td>
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<td></td>
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<tr>
<td>T4</td>
<td>.834</td>
<td>.752</td>
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<td></td>
</tr>
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<td>T5</td>
<td>.822</td>
<td>.772</td>
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<td>RL1</td>
<td>.844</td>
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<tr>
<td>RL2</td>
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<td>.726</td>
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<td>RL5</td>
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<td>RL6</td>
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<td>.744</td>
<td>.672</td>
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<td></td>
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<tr>
<td>CT2</td>
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<td>.862</td>
<td></td>
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</tr>
<tr>
<td>CT3</td>
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<tr>
<td>TR2</td>
<td>.862</td>
<td>.869</td>
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</table>

After carrying out stage 4, evaluation of the adjustment indexes and uni-dimensionality, 7 items were eliminated, resulting 16 items and 4 constructs in the revised measurement model. As a result, in stage 5 (discriminant validity) computation of the relation between the average variance extracted (AVE) and the square of the correlation between the factors were taken. All values were according to the recommendation. In stage 6, reliability of the constructs, AVE was calculated and composite reliability of each construct. All values were above 0.5 for the AVE and above 0.7 for composite reliability, showing reliability of the measurement model. Also, based upon the revised measurement model the adjustment indexes were calculated. All values were accepted. We can observe the final measurement model with the indexes in Table 1.

Finally, step 7 of Koufteros [24], a structural model test, is presented in the next section. Due to the identification of a high correlation between the constructs contractual and relational governance (0.65), between the transactional and contractual governance (0.55), and between the transactional and contractual governance (0.57) a possibility of the existence of a second order construct can be perceived, which may be called supply chain governance. The revised measurement model is presented in Table 5 and the respective adjustment indexes.

<table>
<thead>
<tr>
<th>Revised Measurement Model</th>
<th>Revised Measurement Model</th>
<th>Revised Measurement Model</th>
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<tr>
<td>TR3</td>
<td>.777</td>
<td>21.372</td>
<td>20.443</td>
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<tr>
<td>% of Variance (rotated)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>10.969</td>
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</table>

7.2 Structural Model

The structural model aims to specify the relation between variables and describe the quantity of explained variances. This kind of modeling allows a
simultaneous estimate of a series of distinct multiple equations which are related. Anderson and Gerbing’s [3] recommendation is to establish validity and reliability levels for the measurement model utilized, and thereafter test the structural model. This is the reason why the previous section discussed, presented and analyzed the measurement model to then, derive and analyze the structural model.

According to Hair et al. [21] the covariance either the first or second order models can be replaced by structural relationships, based on the theory and theoretical references used. So, the structural model involving variables from the first and second order is presented in Table 6 and the respective adjustment indexes.

Table 6. First and second order structural models

<table>
<thead>
<tr>
<th>Structural model – First Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2/df: 2.27/ RMSEA: .08/ GFI: .87/ CFI: .92/ NFI: .87/ TLI: .91</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structural model – Second Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2/df: 1.78/ RMSEA: .06/ GFI: .91/ CFI: .95/ NFI: .90/ TLI: .94</td>
</tr>
</tbody>
</table>

7.3 Discussion and verification of the research’s hypothesis

In this section we will present the discussion of results and examine the accurateness of the hypotheses presented.

Hypothesis 2 – IT investment positively influence contractual SCG – was supported by data being statistically significant (0.602). IT investments help companies to control all activities related to supply chain [GEREFFI], coordinate actions and process [16, 17, 18]. For example, we found that EDI was used to control and are related to contracts between companies to plan long term activities. Just investment in ERP to control or coordinate internal action, doesn’t mean use of this investment related to SCG. Companies could impact SCG through IT investments when coordination and control of the activities among companies exist, and there is involvement of executives from these companies.

Hypothesis 3 - IT investment positively influences transactional SCG – was supported by the data and was statistically significant (0.578). Investments in ERP could help companies to reduce cost among companies in the supply chain when it is accompanied by an inter-organizational view that reduces the complexity of transactions.. For Gunasekaran and Ngai [19] EDI provide a structured form for communication and transparency in information, bringing a series of benefits, such as, cost cuts, uncertainty reduction, faster client return and supplier’s service. This IT resource helps businesses in the supply chain by reducing the complexity of such operations, as all information is standardized making it easy to understand and reduce cost of such transactions [29].

Hypothesis 4 – IT investment positively influence relational SCG – obtained the most statistically relevant data support (0.782). From the analyzed companies we can infer that IT investments have been performed with a high concern for the relational elements of SCG. Companies seek to improve the relationship in supply chain sharing interests and goals. According to Daugherty [13] IT has been supporting relationships between buyers, suppliers, manufacturers and distributors, benefiting all participants. Moreover, IT can enable information integration, as well as physical and financial flow between companies and partners in the supply chain [30]. For instance, information sharing is necessary to VMI investment according to Angulo et al. [4], making trust and collaboration essential elements. So, the relationship between companies that utilize such IT require a connection to make information available in a credible and accurate manner, necessary for decision making and integration.

Finally, for Hypothesis 1 – IT investments positively influence SCG – received statistically relevant data support (0.724). Few studies were found [6, 17] connecting IT with SCG. This study proposed that IT investments related to SCG are for monitoring, goods and orders tracking, sharing information with buyers and suppliers, improving integration with buyers and suppliers and reducing transactional costs.
IT investment items with a higher representation in the SCG were the ones connected to reducing costs in the supply chain and to integrating activities and processes with buyers and suppliers. Such evidence is in agreement with previous studies [9, 30] who point out that these activities are of extreme importance in the supply chain.

8. Final Remarks

This study has analyzed the influence of IT investments in SCG and its conceptions. This has been done to better comprehending the multidimensional phenomenon displayed in the structures and processes carried out by companies in a supply chain.

This objective emerged because IT was viewed as very important in carrying out the processes and activities of a supply chain and was recognized as being important in the relationship between IT and SCG [2, 17]. This subject has been considered an advance in the area relating to supply chain management. We found studies relating IT and SCG, but they did not identify elements used in this process. This is the main finding of this study. We identify 5 main elements related to IT investments on SCG (monitoring, products and orders tracking, information sharing, integration and cost reduction) as well as elements should be analyzed to capture the contractual, transactional and relational aspects of SCG.

The objective was reached through a combination of quantitative and qualitative methods. A qualitative technique was applied (in depth interviews and two case studies among Brazilian companies) in an investigatory procedure to identify and analyze the constructs and items to refine the research model.

The use of quantitative technique, through questionnaire survey in more than 120 businesses and 185 valid respondents from different segments with relevance in the country’s economy permitted confirmation of all hypotheses, validation of the research model and analysis of the main results. We found that IT investments influence SCG in a positive and relevant way and in each of its conceptions.

The study has both theoretical and practical contributions. Regarding the first, theories were used to analyze the SCG elements advancing the discussion proposed by Terpend et al. [42]. An addition contribution is that these constructs and elements based on 4 theories were validated using multivariate statistical techniques. The practical contribution is that the results and hypothesis confirmations could help managers to better understand the relationship between IT investments and SCG. To achieve a better result, the managers should focus on IT investments that assist businesses in the supply chain monitoring, products and orders tracking, information sharing, integration and cost reduction.

One of the limitations in the study was the impossibility to generalize the results obtained due to a non-probabilistic sample approach. This model was derived from extensive bibliographic review. Very few works were found in the literature connecting all constructs. This limitation was minimized by the completion of a qualitative stage to investigate and identify items that comprise each of the constructs and how they may be connected. As further research we call for studies to analyze the phenomenon across time, making possible the identification of implications different technologies can have on SCG across dimensions of time. It is possible to use the questionnaire in specific segments of the country’s economy to analyze which SCG prevails and how IT may influence it. Moreover, a study could analyze if relational SCG and transactional/contractual SCG are complementary or substitute forms [26] and the influence of IT investments in this relationship.

10. References
