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**Applying Supply Chain Management models in the banking industry: a Brazilian
case analysis**

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ABSTRACT

The study presents the results and recommendations deriving from the application of two supply chain management analysis models as proposed by the Supply Chain Council (SCOR, version 10.0) and by Lambert (1997, Framework for Supply Chain Management) on the logistics of cash transfers in Brazil.

Cash transfers consist of the transportation of notes to and from each node of the complex network formed by the bank branches, ATMs, armored transportation providers, the government custodian, Brazilian Central Bank and financial institutions.

Although the logistic to sustain these operations is so wide-ranged (country-size), complex and subject to a lot of financial regulations and security procedures, it has been detected that it was probably not fully integrated.

Through the use of a primary and a secondary data research and analysis, using the above mentioned models, the study ends up with propositions to strongly improve the operations efficiency.

Keywords: supply chain management, logistics, banking industry, SCOR, supply chain models.

1. INTRODUCTION

The efficiency of cash operation (distribution and circulation management of cash) has been a constant need since the first banks and paper banknotes were created. An efficient distribution of cash must guarantee its availability at points of sales (bank branches, CSBs – Customer Site Branches, ATMs, etc) at a suitable cost, without this posing an unnecessary withholding or waste of resources to the system's players or to the public in general. The reliability of the whole financial system and of its member institutions can be strongly tarnished in the event of any failure or imperfection in the operation. Furthermore, the costs resulting from wrongly estimated demand or overestimated cash holdings may adversely affect the results of these institutions.

At first sight, the chain for cash supply, collection, counting, authentication and temporary storage seems to be usual. However, a more detailed examination will reveal that it has certain

particularities such as the reverse flow of banknotes and coins (closed-loop supply chain), the necessary withdrawal of unfit banknotes and coins from circulation (soiled, torn or defaced cash, not suitable for transactions) or banknotes and coins suspected of being counterfeit. Another particularity is the dimension of the chain: the cash supply chain is, according to concepts that characterize a supply chain (COOPER, LAMBERT and PAGH, 1997), **complex** because it has a national geographical range, a high degree of granularity and a strong vertical structural dimension at the point of demand.

Despite the always increasing use of “virtual money” in transactions, the volume of cash and its face value continues to grow. The amount of US dollar banknotes in circulation, for example, reached US\$955 billion in 2010 (FMS, 2010), against US\$ 690 billion in 2006 and US\$ 492 billion in 2001 (RAJAMANI, GEISMAR and SRISKANDARAJAH, 2006). In the European Community (Eurosystème), currency in circulation amounted to EUR 840 billion in 2010 (EUROPEAN CENTRAL BANK, 2011), up from EUR 628 billion in 2007 (SCHAUTZER, 2007). In Brazil, the amount of currency in circulation hit the figure of R\$ 151 billion at the end of 2010 (BRAZILIAN CENTRAL BANK, 2011), a dramatic growth in relation to the reported R\$ 80 billion in 2007 (BRAZILIAN CENTRAL BANK *apud* FEBRABAN, 2008).

Regardless of the complexity of the chain and the relevance of the matter, the recommendations and results of academic studies and surveys seem not to have been consistently incorporated to cash supply chain management practices. . On researching the literature on the matter, Rajamani, Geismar, and Sriskandarajah (2006) found no studies on or applications of supply chain management concepts to the problem of cash transfers, a conclusion at which we, the authors of this paper, have also arrived. The scant information and publications available are those found in reports prepared by central banks, government institutions, consulting companies and private banks, in which the academic rigor is not always observed.

On the other hand, banks, governments and economic blocks have a growing interest in enhancing the efficiency of this operation due to the costs it generates for society. The introduction of Euro banknotes in Europe in 2002, for example, forced the reviewing of the cash supply chain in European countries. Crossborder Euronotes management in Europe became one of the objectives of the European Payment Council (EPC), the organization that manages this activity within the Eurosystem (SCHAUTZER, 2007). The US Federal Reserve System is also concerned with cash management, having placed up for discussion and changed the policy on cash recirculation. Following this trend, the central banks of several countries are experimenting changes in their public cash circulation policies, resulting in different operations and chain configurations (RAJAMANI, GEISMAR and SRISKANDARAJAH, 2006).

Because it is one of the largest operations in the world, due to the size of its economy and its territorial area, cash logistics in Brazil is particularly sensitive to management failures. The growth of the Brazilian economy has caused the volume of currency in circulation to rise exponentially, increasing the need for a greater understanding of this operation (OKINO, 2010).

Therefore, this article describes and analyzes, based on reference models, the cash supply chain in Brazil, and suggests adjustments that could be made to improve its efficiency. The first model used is the supply chain framework proposed by Cooper, Lambert & Pagh (1997). This model provided an strategic and structural assessment of the chain. The second model used is the Supply Chain Operations Reference Model (SCOR), version 10.0 (SCC, 2010a). This model allowed for a deeper operational and functional assessment.

In section 2 we describe the cash supply operation with a focus on distribution and summarize the main characteristics of this operation in Brazil. Section 3 briefly features the main characteristics of the Supply Chain Management (SCM) models used to analyze cash operation in Brazil. Section 4

describes the research methodology used in this study. Based on the SCM models and the methodology featured in the preceding section, Section 5 lists the main study results and discusses these results. Section 6 carries the conclusion and suggests improvements for managing the Brazilian cash supply chain and proposes possible study extensions.

2. CASH SUPPLY CHAIN AND THE BRAZILIAN OPERATION

The supply of cash by banks to both bank customers and non-bank customers is basically a logistics operation and depends on a wide network of points of sales formed by bank branches, customer site branches (CSBs), automated teller machines (ATMs), financial companies (many of which are associated with commercial banks), bank correspondents (companies that provide bank services under special bank agreements) and large retailers, which collect and transfer on large volumes of cash to the public. In this operation, these points of sales, which can be directly accessed by the public, are in turn supplied by a huge network of suppliers, especially by cash transporters and currency custodians (in Brazil, the official custodian designated by Central Bank is currently Banco do Brasil S.A.).

Figure 1 shows a simplified diagram of the cash supply chain:

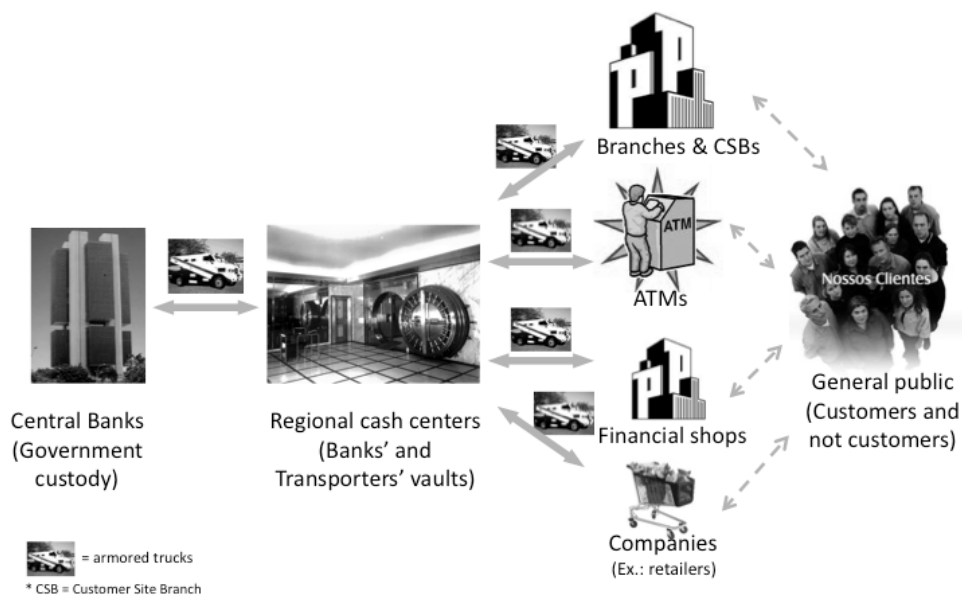


Figure 1: Simplified diagram of the cash supply chain.
Source: prepared by the authors.

Although at a first glance, it appears to be a common logistics operation involving a few links in the supply chain, the cash operation has certain characteristics that make it very complex and unique, the most relevant of which are:

1. The materials do not flow in one direction only since not only is cash supplied to the market (customers and the public in general), but it is also returned by the public, refurbished with the identification of counterfeit or unfit banknotes, and redistributed to the network (OKINO, 2010). The structure is similar to that of reverse logistics and has the characteristics of a closed-loop supply chain (RAJAMANI, GEISMAR and SRISKANDARAJAH, 2006).
2. The significant amount of stored and transported material, which render relevant the financial aspects (interest on cash holdings/idle cash) and security aspects (thefts and robberies) of this operation.
3. High quality service is required since the image of strength and reliability of the financial system as a whole or one of its member institutions may be seriously damaged if the points of sales are out of money, and this may even cause a bank run, which could undermine the financial health of these institutions.
4. Because cash is a commodity, there is an intrinsic possibility of competing banks entering into a partnership in this operation. This partnership may be forged both to supply the cash (interbank exchange), to share transportation structures for bank deliveries (e.g. contracting a single cash transportation company to supply all banks), and even to share supply frameworks (e.g. share self-service sales points – ATMs).

5. Although material (banknotes and coins) transportation is in general outsourced to cash logistic providers, it is managed and coordinated directly by the banks. Therefore, the “transporter” node is not actually independent from the other node (“bank”).

With respect to the Brazilian operation, the total amount of cash (paper banknotes in circulation) in Brazil was roughly R\$ 120 billion in April 2010, according to Brazilian Central Bank data (2010a). Ninety-seven billion reais (R\$ 97 billion) or 81% of this total, which accounts for 53% of the means of payment used by Brazilian population, is in the hands of the public and R\$ 23 billion, or 19%, is bank holdings to guarantee the quality of customer service.

This amount is still low in comparison with other countries. Currency in circulation data as a percentage of GDP gathered from other central banks of various countries (see table below), show this relatively low use of cash in Brazil.

Table 1 – Currency in circulation as a % of GDP

Year	Brazil	England	Europe	Japan	USA	Mexico
2002	2.8%	4.0%	5.5%	15.3%	6.3%	3.9%
2003	3.2%	4.2%	6.5%	16.1%	6.3%	4.2%
2004	3.5%	4.0%	7.1%	15.9%	6.2%	4.5%
2005	3.4%	3.6%	6.7%	14.3%	6.1%	4.7%
2006	3.8%	4.0%	7.9%	14.8%	5.9%	5.0%

Source: Central Banks and World Bank apud FEBRABAN (2008).

Note: adapted by the authors.

The analysis of the evolution of currency in circulation in Brazil shows that there has been an outstanding growth since the country managed to stabilize its economy in the ‘90s, possibly pointing to a trend that is very similar to the “currency in circulation vs. GDP” rate posted in developed countries.



Figure 2: Currency in circulation evolution in Brazil.

Source: Brazilian Central Bank apud FEBRABAN (2008), adapted by the authors.

Note: Currency in circulation in 1994 = R\$ 7.7 billion. 2008-2011 = forecast.

3. REFERENCE MODELS

Despite the specific features of the Brazilian cash operation mentioned in the preceding section, its configuration is characteristic of a supply chain. Therefore, the Supply Chain Management approach may provide for a more structured description and analysis of this operation.

The Cooper, Lambert & Pagh (1997) model considers that Supply Chain Management (SCM) encompasses the integration of all internal and external supply-related activities via the distribution channel. This framework is made up of three main components, all of which are closely related: Business Processes, Management Components and Supply Chain Structure.

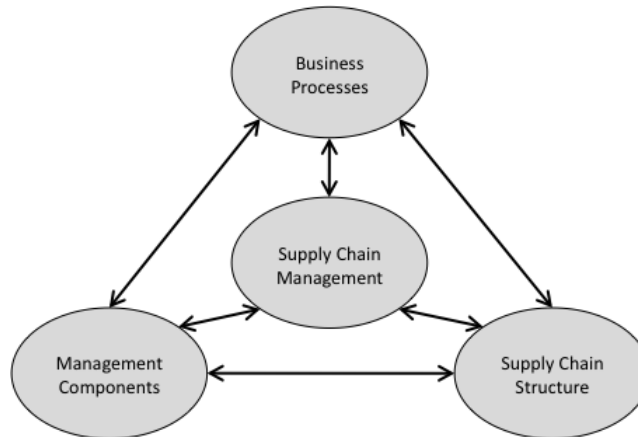


Figure 3: Supply Chain Management Framework Components
Source: adapted from Cooper, Lambert, Pagh (1997)

The success of supply chain management hinges on establishing which are the chain's key players; which are the SCM processes connected to these players; and what type or level of integration ought to be applied to the processes (LAMBERT, COOPER & PAGH, 1998).

The choice of the second reference model, the Supply Chain Operations Reference Model (SCOR), to describe the cash supply chain management in this paper was due to the fact that this framework is one of the most generally accepted models in industry to represent and analyze supply chain management. SCOR is one of the models that enables managers to simplify the complex supply chain management framework and makes their strategic decision-making process easier (HUAN, SHEORAN and WANG, 2004).

The SCOR model combines the vision of the business processes with metrics, best market practices and the use of information technology in a single structure in order to foster communications between the supply chain players. As a result, it heightens management efficiency of both the supply chain as well as of the other activities pegged to it (SCC, 2010a).

The SCOR model was developed to describe all business processes associated with all phases of satisfying a customer's demand (SCC, 2010a). It considers supply chain activities a series of cross-

industry processes (Plan, Source, Make, Deliver and Return) performed in each node of the chain, which are interrelated and deemed critical to chain management (LAI, NGAI and CHENG, 2002).



Figure 4: The SCOR model structure.
Source: SCC (2010b).

SCOR organizes the processes in three hierarchical levels to describe the entire chain supply operation (Supply Chain Council - SCC, 2010a). The first level is the most comprehensive and strategic. The next levels add on process details successively to those of the former levels. The standard cross-industry levels are the following:

- Level 1 – Top Level: Process Types.
- Level 2 – Configuration Level: Process Categories.
- Level 3 – Process Element Level: Decompose Processes.

After Level 4, the processes are specific to each company or industry in which the company operates.

In this study, we considered the “bank” our focal company and, because of the methodology elected, we chose describe the cash operation using the SCOR framework to Level 2, i.e., the Configuration Level.

4. RESEARCH METODOLOGY

With a view to achieving its established goal, this study was structured on five fundamental phases, as follows:

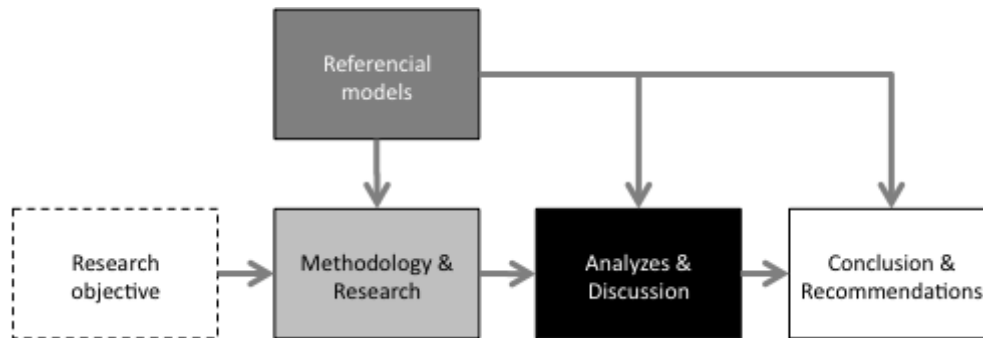


Figure 5: The methodological structure of the research.

Source: prepared by the authors.

- a. Research objective: in this initial phase, we started with a general overview of the cash operation and established that the goal would be to analyze cash operation based on Supply Chain Management concepts. This phase serves as the guideline for the entire work and defines the scope of the study;
- b. Reference models: we chose two models: the supply chain management framework proposed by Cooper, Lambert & Pagh (1997) and the Supply Chain Operations Reference model framework (SCC's SCOR, 2010a);
- c. Methodology and Research: During this phase, we identified a need for a primary research to supplement the secondary data resulting from the survey carried out among institutions, regulatory agencies and associations. This was carried out using a specific questionnaire form,.
- d. Analyses and Discussions: based on the data collected through the primary and secondary surveys and on literature theoretical referrals, we then moved on to describe, analyze and discuss the Brazilian cash operation in this phase;
- e. Conclusion and Recommendations: we closed the work by reviewing the research results and comparing them with the proposed goal. We also propose measures for the improvement of cash supply chain management in Brazil.

Table 2 shows the main sources of information on the dimension of the SCM model used as reference.

Table 2 – Research type for each SCM model dimension.

Dimension	Characteristic or Component	Type of Research
1 – Supply Chain Structure	1.1 – Members identification	Primary and Secondary
	1.2 – Dimensions	Primary and Secondary
	1.3 – Process links	Primary
2 – Business Processes	2.1 – Customer relationship management	Primary and Secondary
	2.2 – Customer service management	Primary
	2.3 – Demand management	Primary
	2.4 – Order fulfillment	Primary
	2.5 – Manufacturing flow management	Secondary
	2.6 – Procurement	Primary
	2.7 – Product development and commercialization	Primary
	2.8 – Returns	Secondary
3 – Management Components	3.1 – Planning and Control	Primary
	3.2 – Work structure	Primary
	3.3 – Organization structure	Primary
	3.4 – Product flow facility structure	Primary
	3.5 – Information flow facility (IT) structure	Primary and Secondary
	3.6 – Product structure	Primary
	3.7 – Management methods	Primary
	3.8 – Power and leadership structure	Secondary
	3.9 – Risk and reward structure	Primary
	3.10 – Culture and attitude	Primary

Source: prepared by the authors using the Cooper, Lambert & Pagh's SCM model (1997) as reference.

The primary data survey was conducted using different questionnaires for each type of player, featuring a total two hundred sixty eight (268) open questions, which were answered by executives involved in this type of operation. Thirteen (13) officers from various banks, Brazilian Central Bank, cash transporters, retailers (large corporate customers) and the custodian bank (Banco do Brasil S.A.) were interviewed, as shown on table 3.

Table 3 – Companies that participated in the survey of the cash supply chain.

Type of Player	Company name	Company's full legal name
Regulatory and government custodian	BACEN	Brazilian Central Bank
	Government custodian	Banco do Brasil S.A.
Banks	Itau	Itau Unibanco S.A. (1)
	Unibanco	Itau Unibanco S.A. (1)
	CEF	Caixa Economica Federal
	Bank 4	Bank 4 (confidential)
Cash transporters	Protégé	Protege S.A. Prot. e Transp. de Valores
	Rodoban	Rodoban Seg. e Transp. de Valores Ltda.
	Transvip	Transvip Trans. de Val. e Vig. Patr. Ltda.
	Transporter 4	Transporter 4 (confidential)
	Transporter 5	Transporter 5 (confidential)
Customers	Ultragas	Companhia Ultragas S.A.
	Customer 2	Customer 2 (confidential)

Note: In spite of the Itau-Unibanco merger announced in November 2008, these banks were considered separately in this study.

The gathering of secondary cash operation data was made through a survey conducted among organizations involved in this operation, the main organizations being Brazilian Central Bank (BACEN), the National Federation of Banks (FEBRABAN) and the Brazilian Association of Cash Transporters (ABTV).

5. RESULTS AND DISCUSSION

The strategic study of the cash operation analyzed each of the three dimensions of the Lambert, Cooper & Pagh (1998) SCM model and its twenty-one (21) sub-components, as shown in Table 2 in the preceding section.

Figure 6 shows the schematic diagram of the cash supply chain framework, business processes and management components.

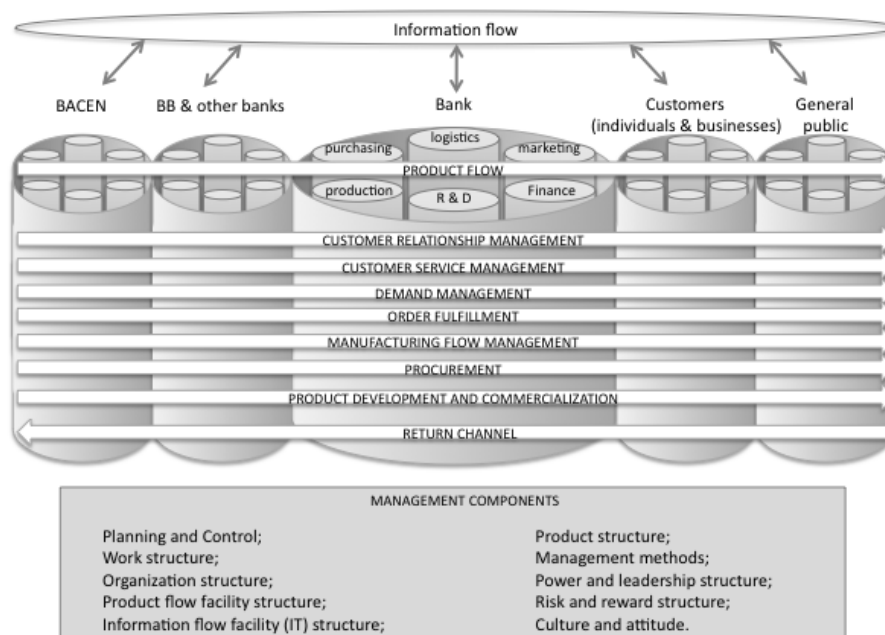


Figure 6: Lambert's SCM model applied to the Brazilian cash supply chain.
Source: prepared by the authors using Lambert & Cooper (2000).

The Supply Chain Operation Reference Model (SCOR) model was applied to describe the cash supply operation using the generally accepted “syntax” in the field of Supply Chain Management.

It was possible, based on the primary and secondary survey results, to build a schematic diagram representing the Brazilian currency chain, using the fundamental Level 1 processes (Plan, Source, Make, Deliver, Return) of the SCOR framework.

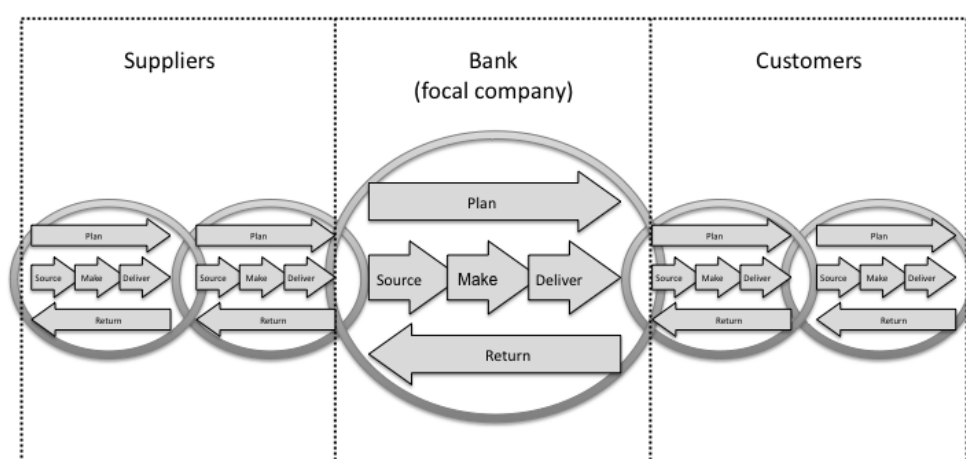


Figure 7: Process type diagram of the Brazilian supply chain.
Source: prepared by the authors using the SCOR framework (SCC, 2010).

On decoupling stage one processes to fit the stage two description of the cash operation in Brazil we arrived at the business scope diagram of the supply chain.

This diagram seeks to identify the main players involved in the supply chain, the various different companies or company units involved, and the main material and information flows between these players.

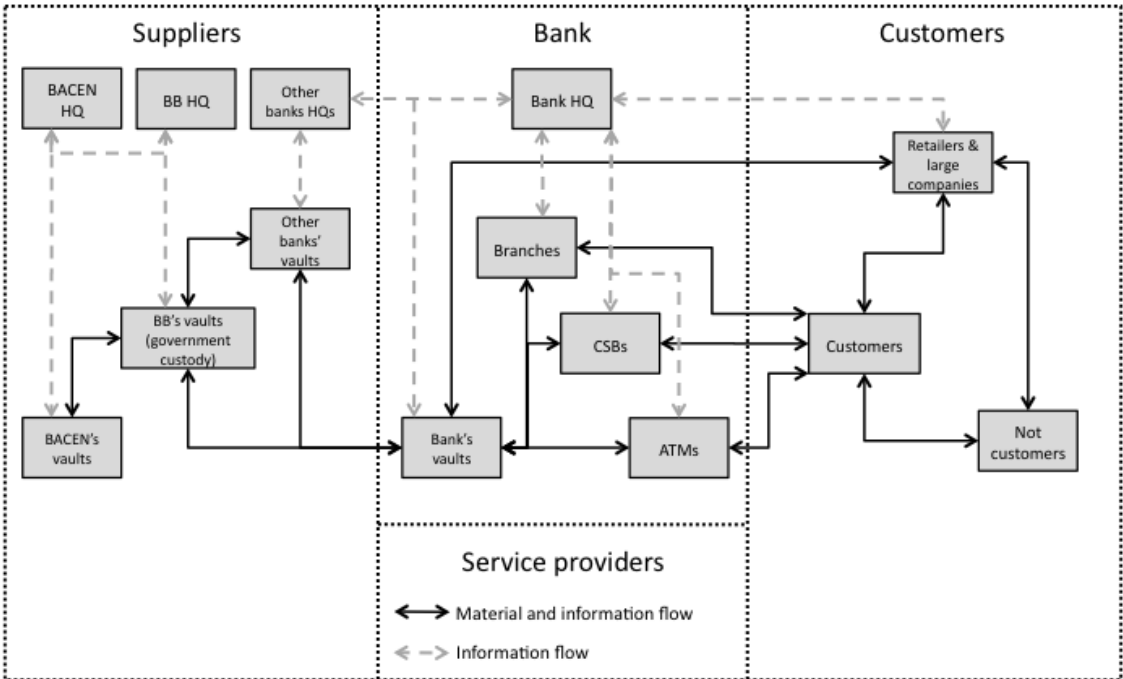


Figure 8: Business scope diagram of the Brazilian supply chain.
Source: prepared by the authors using the SCOR framework (SCC, 2010).

The representation of Level 2 processes of the SCOR model (SCOR Thread Diagram) was made based on the SCOR Level 1 process details presented before, coupled with the data gathered from the primary and secondary surveys mentioned in the preceding section.

We elected to break down the representation of the cash operation in Brazil into three SCOR thread diagrams because there were three different cash product flows: cash delivery, collection and refurbishment.

Figures 9, 10 and 11 present the cash operation's SCOR Thread Diagrams.

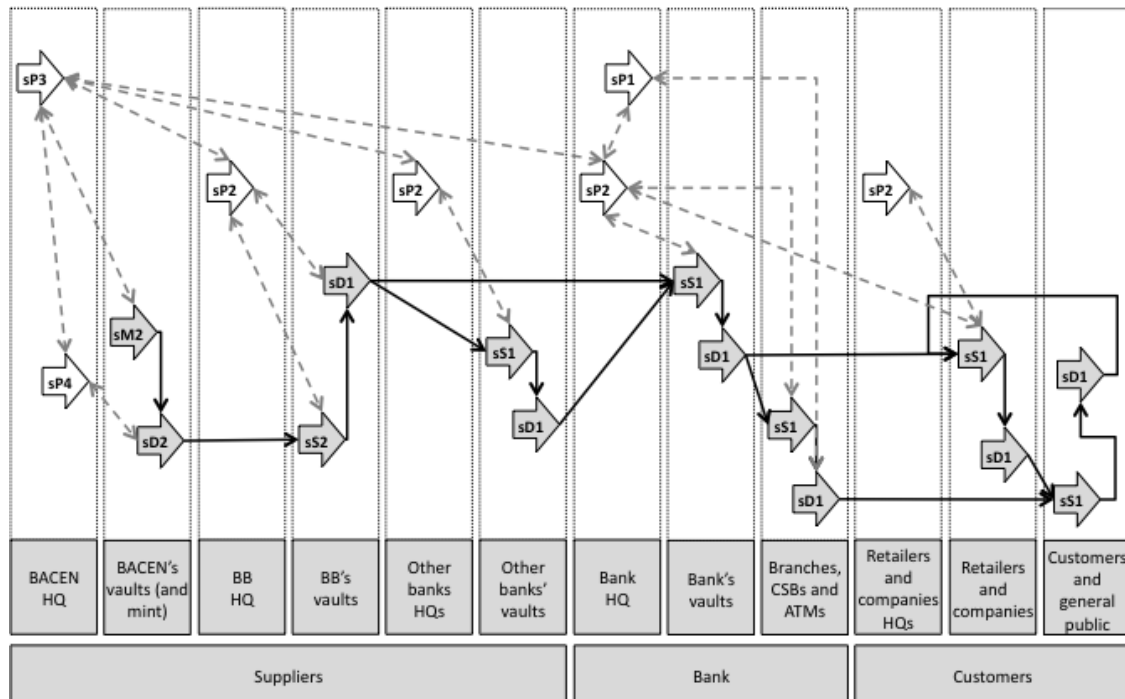


Figure 9: Thread diagram of the cash delivery operation.
Source: prepared by the authors using the SCOR framework (SCC, 2010).

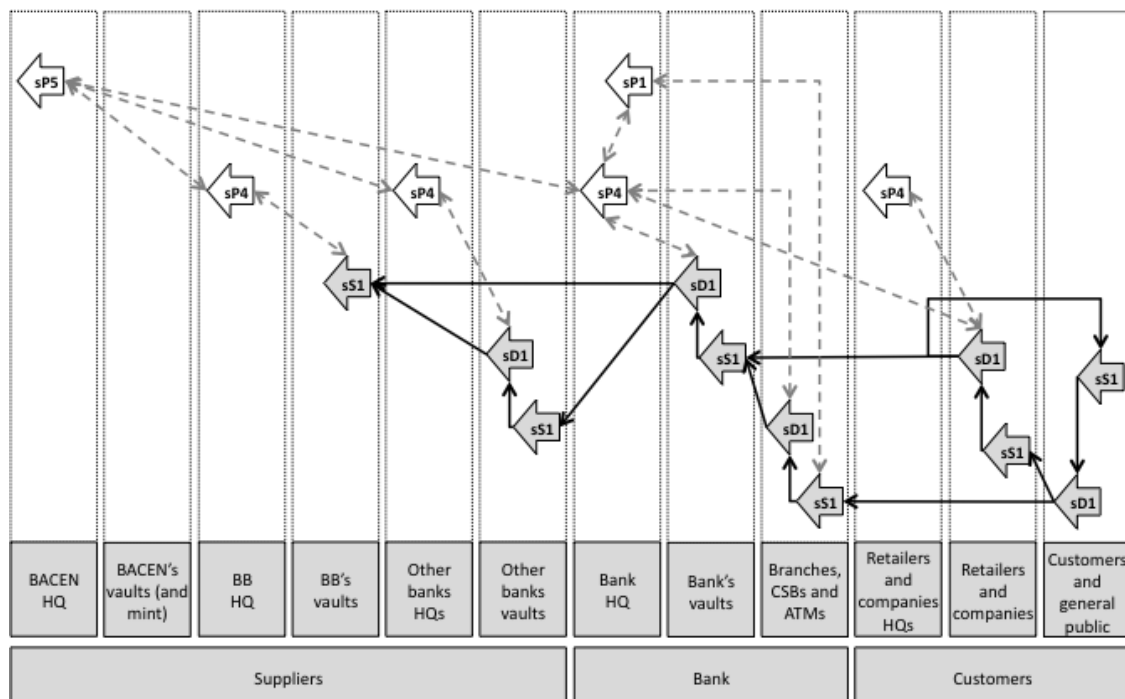


Figure 10: Thread diagram of the cash collection operation.
Source: prepared by the authors using the SCOR framework (SCC, 2010).

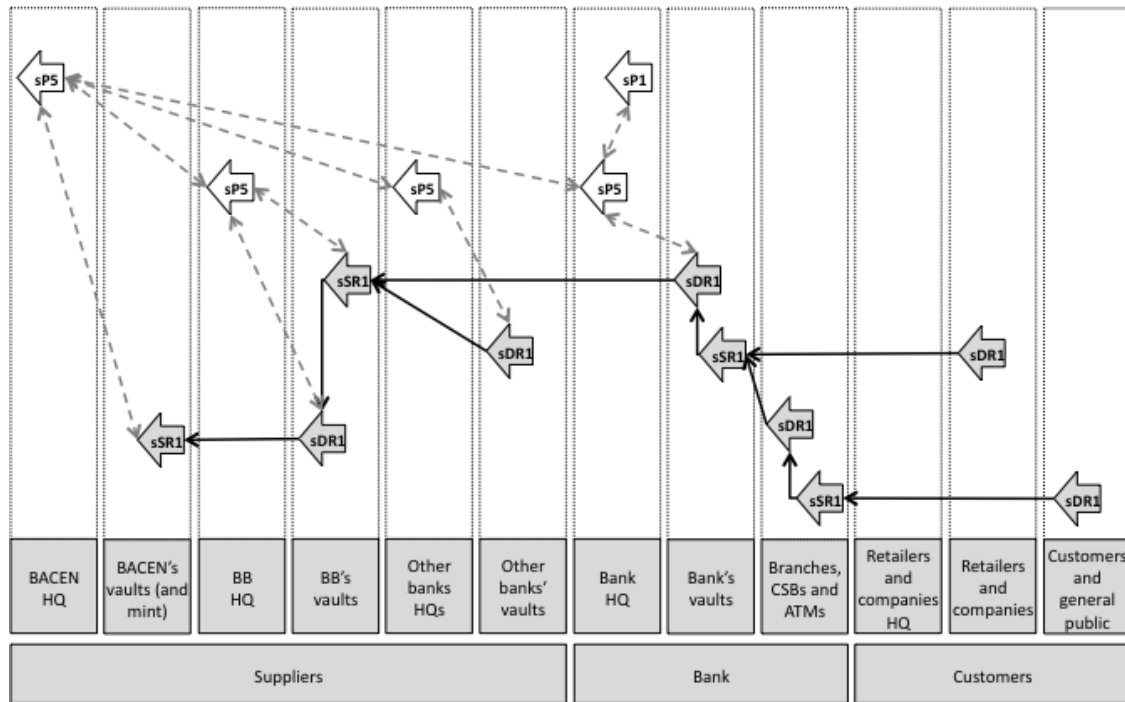


Figure 11: Thread diagram of the cash refurbishment operation.

Source: prepared by the authors using the SCOR framework (SCC, 2010).

The Level 2 process categories of the SCOR framework were used to build the thread diagram, as per the framework definitions. For example, process category “sP2” stands for “Plan Delivery”.

The main highlights resulting from using the two models to analyze the cash supply operation in this paper are the following:

- Although they simply provide services to the banks, the cash transporters play a fundamental role in the cash supply operation.
- There is a strong interaction among individual customers, corporate customers (large, retail and ordinary customers) and the general public. This interaction causes the cash flow to customers to sometimes be made via bank sales points (branches, ATMs, etc) and, at others, directly via bank vaults.
- The chain under analysis presents a small horizontal dimension (few links), but a high vertical dimension (great number of players at each link).

- d. It was found that as the number of vaults and transporters expands in any given region, the chain's vertical dimension increases, a vaults-transporters inter-relationship is established and product flow becomes more complex.
- e. Banco do Brasil S.A. operates as both a bank and the official currency custodian. This double role possibly constitutes a conflict of interests in the chain operation.
- f. Because it stems from a variety of commercial and social activities, the interaction between the bank, customers and the public in general is diverse and granular, which adds complexity to demand management processes as well as to consumer satisfaction processes...
- g. The two-way product flow, that is, customer cash withdrawals and deposits, at almost all of the chain links is an unusual element of complexity in the cash supply chain's business processes. This complexity, coupled with the fact that the chain has a strong vertical dimension, requires that this cash supply operation be treated as a "network" rather than a chain, as proposed by Christopher (1998).
- h. On analyzing the consumer service management process, we found that although the banks are focal nodes, they do not have full control over cash delivery because they depend on the official custodian and the policies established by Brazilian Central Bank. Consequently, there may be periods in which cash supply is deficient, given the impossibility of developing alternative suppliers for paper banknotes and coins.
- i. Demand management by cash transporters is complex due to reported peaks in demand. This complexity is further aggravated due to the complexity of the abovementioned delivery "network" involving multiple banks, transporters and bank sales points in the same area.
- j. On analyzing the return channel for treating unfit and counterfeit cash, we identified several particularities. Differently from regular "reverse logistics", in the return channel, banks and

transporters handle the cash when they collect it from the public; so there is no need for the product delivery process for customer disposal purposes. This simplifies the process.

- k. Brazilian Central Bank faces difficulties in planning demand due to a lack of direct information on cash supplies to customers and to the public in general (this is monitored indirectly via surveys).
- l. On analyzing the information flow framework (IT), we found that there was no single or standard structure for contacts between banks and transporters or even between banks and major customers. This makes data alignment throughout the chain difficult and causes the so-called bullwhip effect.
- m. On analyzing the power and leadership structure of the cash supply chain, we found a concentration of suppliers in the transportation segment and a need for heavy investments in installations (legislation and security requirements). These two factors (current strong concentration and need for capital investments) constitute barriers to the entry of new player, according to Porter's (1979) competitive forces model. Any alternative plan (e.g. development of new suppliers) would only be possible if other forces such as customer power (of banks) or government power (legislation, Federal Police regulations, etc) came into action.
- n. The assessment of culture and manager's attitude suggests that a greater alignment between the cultures of the transporters and the banks on customer satisfaction would pose a window of opportunity for improving the relations between these players and intensifying outsourcing.
- o. The SCOR-based analysis of the operation enabled us to establish that "other banks" are shown on the diagrams as playing practically the same role as the official currency custodian in the delivery and collection flows. The fact that they have similar roles may represent an opportunity to simplify and optimize the operation.

- p. The analysis of the information flow in the SCOR diagrams is broken down into “inbound” and “outbound” from the focal bank node. BACEN has strong control over supply (“inbound”) and other banks have strong control over demand (“outbound”), but there seems to be a lack of integration between the information held by the two sides of the chain.

6. CONCLUSIONS AND RECOMMENDATIONS

The description and analysis of the cash supply operation in Brazil based on the Cooper, Lambert & Pagh (1997) Supply Chain Management (SCM) model and SCC’s SCOR (2010a) fostered the identification of the following opportunities for improving the management of this supply chain:

- Use shared vaults: reduce the number of bank, transporters and custodian vaults located in the same area by having the players share vaults.
- Improve demand information alignment between the banks and transporters: this involves improving cash transporter-bank communications, which will reduce distribution, transportation and processing efforts resulting in a more smooth distribution of cash inventories along the chain.
- Integrate strongly the IT systems: although there is a single standard communications system operating between the banks, the official custodian (Banco do Brasil) and BACEN, called SPB-STR system, there is no such standard communications system for the other players, which greatly hampers operation and planning.
- Implement service level agreements: as a good SCM practice, the cash transportation, custody and processing services should be hired and managed based on indicators.
- Implement collaborative planning, forecasting and replenishment: the chain’s vertical dimension and the operation’s nationwide range require efficient planning, forecasting and replenishment

based on more decentralized information, so that the players can cooperate in providing this information.

- Implement cross-docking: the analysis showed that there is room for transportation optimization, achievable by applying the cross-docking concept, especially in relation to cash deliveries from BACEN (or the Brazilian Mint) to the official custodian, banks and large corporate customers.
- Apply the Lean Methodology more intensively: this methodology aims to restructure the process flow with a view to paring down losses as a result of reducing reprocessing of cash transfers between banks and also between the bank and the custodian; optimize transportation (eliminating unnecessary movements) by improving the chain framework configuration; and reduce custodians' cash holdings by enhancing custodian, bank and customer synchronization.
- Apply the efficient supply chain principles: the analysis of chain demand and supply uncertainties as proposed by Lee (2002) suggests that greater efficiency can be sought by establishing an efficient information exchange system throughout the chain.

The exploratory study of this research enabled us to characterize the cash operation in Brazil by applying two Supply Chain Management (SCM) models. The research was made based on a secondary data survey conducted among businesses connected with this activity such as the Brazilian Association of Cash Transporters (ABTV), Brazilian Federation of Banks – National Cash Studies Center (FEBRABAN-CENEN) and Brazilian Central Bank, and a primary data survey among managers and officers of some leading companies in this industry, including banks, customers and transporters.

The use of the mentioned models, reinforced by the established methodology, resulted in a comprehensive description of cash operation in Brazil and a subsequent analysis of this operation.

Although the objectives of this study research have been addressed, the possibilities of conducting new studies on the cash operation in Brazil and in other countries have not been exhausted.

Because of its exploratory nature, this study merely provides a general and broad overview of the cash operation by applying SCM concepts. As suggestions for future research projects, we highlight: possible studies on the performance of the current cash supply chain; the influence of the chain's current configuration (framework) on this performance; the application of SCOR performance metrics on the cash operation; the use of the Lean methodology to improve chain results and other related topics.

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