

Economic Model of Sustainable Value Chain in Passenger Waterway Transportation Service

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Abstract—The service of passenger waterway transportation lacks economic models that help in designing and implementing strategies to ensure its sustainability in several aspects. The level and behavior of costs, though not the only one, is of particular importance in these models. Indeed, there are several aspects that should be also considered namely, intermodal competition; quality of service; regulatory environment of public concessions. Furthermore, it is important to consider that companies no longer exist in isolation, but they are part of highly integrated value and supplies chains. Therefore, this work analyzed the sustainable value chain in service of passenger waterway transportation using the tools of strategic cost management. The research work followed three components of analysis: (1) definition of the basic elements of sustainable value chain; (2) identification of main activities and restrictions to value chain development and critical aspects for service sustainability; (3) development of an economic model. The case study is a passenger transportation company located in Amazonia, Brazil. The conditions of economic viability of the different crossings were analyzed. As a result, a model was developed, with the proper characterization of the cost structure and the value creation process in passenger waterway transportation. This study may constitute a reference for future more sophisticated applied works of optimizing the resources involved and supporting the decision-making.

Keywords—Activity-based costing, cost management, value chain, waterway transportation.

I. INTRODUCTION

THERE are several criticisms regarding traditional economic analysis approaches, because they present only revenues, costs from an accounting perspective, without considering non-monetary aspects, such as customer satisfaction, process flexibility and environmental negative or positive impacts [1]. The ideal would be to include the evaluation of other non-financial assets, such as motivated and skilled employees, efficient internal processes, high quality products and services, satisfied and loyal customers, etc. Traditional costing systems also do not adequately translate the value creation process that relates resources consumed, activities developed and products or services produced for different categories of customers. This reality has motivated the emergence of new costing models, such as Activity Based Costing (ABC) [2].

On the other hand, the fact is that companies can no longer create value and obtain sustainable competitive advantages if they are not able to do a rapid allocation of new technologies to physical assets, and achieve excellence of financial asset and liability management [3]. In this scenario, strategic cost management emerges as one of the instruments that can be used in management accounting to obtain, analyze and

optimize the company's costs in accordance with its strategy, the optimized use of resources and the efficiency of activities performed [4].

In Brazil, the companies of water transportation of passengers operate under the regime of public concessions being, in the interstate and international sphere, the activities and sales prices regulated by the National Agency of Water Transportation (ANTAQ) and, in the state sphere, by the Service Regulation Agencies of each State. Considering that companies of this type can have little influence on the fares that make up their passenger billing, due to the regulation, and excluding from this situation the revenues earned from the transport of parcels. Furthermore, due to the requirement of the Brazilian Navy, they also have crew scale restrictions that affect the desired results, and business sustainability.

In the Amazon region, companies of passenger water transportation, although performing their activities through public concessions, are not exempt from the current market difficulties. This fact can be verified through the existing competition between the activity of waterway passenger transport and other modes. For example, air transportation for longer distances, a modality that is practicing prices closer and closer to the fares charged in hydro-way transport and, in some cases, with road connections, transport carried out with a private vehicle in shorter stretches of trips, which has been increasing in recent times due to the increasing number of cars [5].

Some of the relevant factors for which the companies need to pay attention and draw strategies: ensuring the conquest and permanence of new customers; expanding the area of operation, achieving the best quality of services; maintaining the satisfaction of its employees and, economically, managing its resources. They'll act as necessary steps for the success of the company and the achievement of its objectives. The level of information available to managers is important for organizations to be able to define the right strategies at the right time. The new operational environment, which is based on information, requires companies to have an adequate management tool to manage and measure performance.

Under this approach, managerial accounting emerges as an important source of information. In the search for more accurate information, managerial accounting assumes the role of offering elements that translate the organization's performance, seeking information in financial accounting and production records [6]. One of the instruments addressed by managerial accounting is strategic cost management, which consists of the use of cost information to develop and identify superior strategies that will produce a competitive advantage [7]. Therefore, considering globalization and the constant

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changes in the economic market, it can be verified that strategic cost management is an instrument, nowadays, that can provide information about costs that will be used in the search for the competitive advantage.

And, in this context, this research project aimed to identify the value chain and analyze the costs of a company of water transportation of passengers in light of the strategic management of costs, considering the internal characteristics of the business and the external environment in which the company is inserted. As a main hypothesis, it is assumed that a strategic vision of the value chain may bring sustainability to the business in water transportation companies. For that it is important to have a sustainable value chain economic model.

II. THEORETICAL FRAMEWORK

Strategic cost management considers a broader context, where strategic elements become more aware, explicit and formal [8]. It can be seen that strategic cost management goes beyond the scope of cost analysis, which addresses financial aspects for decision-making. In this domain, research is directed at cost allocations that are difficult to measure and affect cost accounting, requiring alternative forms of evaluation. There are several studies with the purpose of identifying more specific decision criteria, to be applied in empirical research in managerial accounting [9]-[19]. In the transport services sector, there are some recent studies, mainly in the logistics sector [20].

The development of cost analysis models with a strategic management vision has as theoretical reference the work of Cooper and Kaplan, with the activity-based costing methodology [21], representing a rupture with traditional costing systems and adapting management accounting to a new situation in terms of markets and industries. The Activity-Based Costing (ABC) method considers that to produce a product or service it is necessary to perform certain activities that, in turn, consume resources. Thus, this costing system accumulates resource overhead for the related activities, followed by the allocation of the cost of such activities on the cost objects by cost drivers [22].

Cost drivers are crucial elements for this approach because they demonstrate and quantify the cause-effect relationship between resource use, activity performance and cost objects [23], [24]. The information extracted from the ABC model allows us to identify activities that add value and those that do not, the latter being able to be reduced or eliminated without compromising the value created for customers [25].

The analysis of costs goes through the study of the sustainable value chain, which seeks to analyze the generic value chain [26] in order to show which business activities can be directed to a sustainable value. The activities are the pillars of building competitive advantages, being resource consumers on one-hand and value creators on the other.

A sustainable value chain can be developed through the implementation of actions directed to sustainability, and it is necessary that organizations establish production practices and technologies that focus on reducing cost impacts in their activities. Studies prove that value chain management enables competitive advantages such as cost leadership or differentiation [27]-[31].

As this was an exploratory and empirical study for a service of waterway passenger transport, the study was divided into three phases:

A. Definition of the Elements of the Value Chain

A document analysis was carried out for the general characterization of the company and the service, and data from the cost structure was obtained to identify the value chain of the service and the resources employed. At this stage, empirical observations of the service were made, notes were taken of the activities developed in the various sectors and interviews were conducted at the company. It was also possible to identify the drivers of the activities and the structure of the value chain.

B. Analysis of Activities and Critical Aspects of the Service

A reasonable level of aggregation was also sought, considering the difficulties that defining each activity would bring to the information system. At this stage, interviews were conducted with the company's employees, since the experience acquired can provide reasonable estimates of the consumption of resources by the different activities, as well as to establish the cause-effect relationship between the consumption of resources and their activities. Finally, defined the activities, the resources that each activity consumed were allocated to them.

C. Development of the Economic Model

In this phase, we sought to develop the economic model, in view of the value chain and its activities, observing the company's strategies to have a competitive advantage, the main restrictions to the development of the chain and, in terms of internal aspects, the mechanisms established for the sustainability of the service.

The ABC methodology seeks to answer: Which activities are being executed by the organization? How much does it cost to be executed? How much of each activity is necessary for the products and services, considered as cost objects? In short, in ABC the cost of a product or service results from the sum of the direct costs and the cost of all the activities necessary to produce the product or service [32], as presented in Fig. 1.

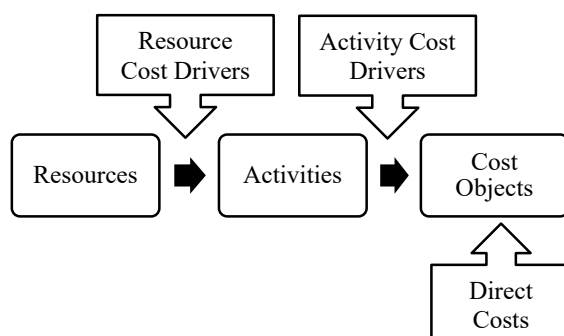


Fig. 1 Activity-Based Costing method Assumptions

Fig. 1 indicates that ABC is a method with two main steps: the first, in which the costs of resources consumed are allocated to the various activities of the organization. In this

step, resource drivers are used to distribute the costs consumed over more than one activity. Second, the costs of the activities are allocated to the cost objects based on their consumption of the former. This allocation is done using activity cost drivers. Finally, direct costs are added to the cost objects, having the total cost of the product or service.

The case study in question was developed in a preliminary phase of recognition of the value chain of the service, identification of resources and activities and conceptual determination of the economic model. The research does not intend to discuss the strategic cost management approach instead, it is focused on analyzing the conditions towards a sustainable value chain.

IV. CASE STUDY

The case study was developed in a corporation of three companies with three services of water transportation crossing in the Metropolitan Region of Belem, for passengers and cargo, and vehicle transportation. The services are the following:

1. Belem-Camara crossing: daily frequency of the service for passengers, authorized by state entity: ARCON. Part of the Belem waterway terminal to Marajo Island, in a terminal called Camara. The crossing is 30 nautical miles long with two equipments: ship for 600 passengers and boat for 137 passengers. There is a competitor with similar equipment and, another one with a ferryboat.
2. Crossing Belem-Arapari: daily frequency of the service, for the transport of passenger vehicles and cargo, authorized by state entity: ARCON. The trip begins in another waterway terminal on the south bank of Belem and ends into a terminal called Arapari, in the southeast of the State of Pará. The crossing is 10 nautical miles long with two types of equipment: a pusher and a ferry, which adds up to an average of 50 standard capacity vehicles. There are three companies competing in this crossing.
3. Crossing Belem-Cotijuba: daily frequency of the service, for the transport of passengers and cargo, through a concession contract with the Belem City Hall. From the Belem's terminal to Cotijuba Island waterway terminal. The crossing is 10 nautical miles long with one equipment: a ship for 350 passengers.

The company also has a replacement equipment, a ship for 238 passengers and, together with three other companies on the Belem-Arapari crossing, it shares a ferryboat as replacement equipment. The three crossings have some workforce resources of each equipment independently, with some sharing of the crossings for operational and administrative resources on land. The mission of the company is to meet the needs of the demand efficiently, at the lowest possible cost. In Fig. 2 we have the representation of the different crossings.

In an interview with the company's board of directors, the main challenges were identified:

- The out-of-date tariff for the Belem-Camara and Belem-Arapari crossings, in the last 20 years, and without perspective of adjustment by the regulatory agency;
- The high rate of seasonality of the service, where only in two months of the year can one actually have the capacity of supply filled;

The large number of equipments of competitors in the Belem-Camara and Belem-Arapari crossings and, in the Belem-Cotijuba crossing, and the competition from informal transport;

- Shortage of skilled labor;
- Conflicts of operational nature and financial adjustment with competing companies.
- Inefficiencies resulting from predominantly family-based management models without professional management.

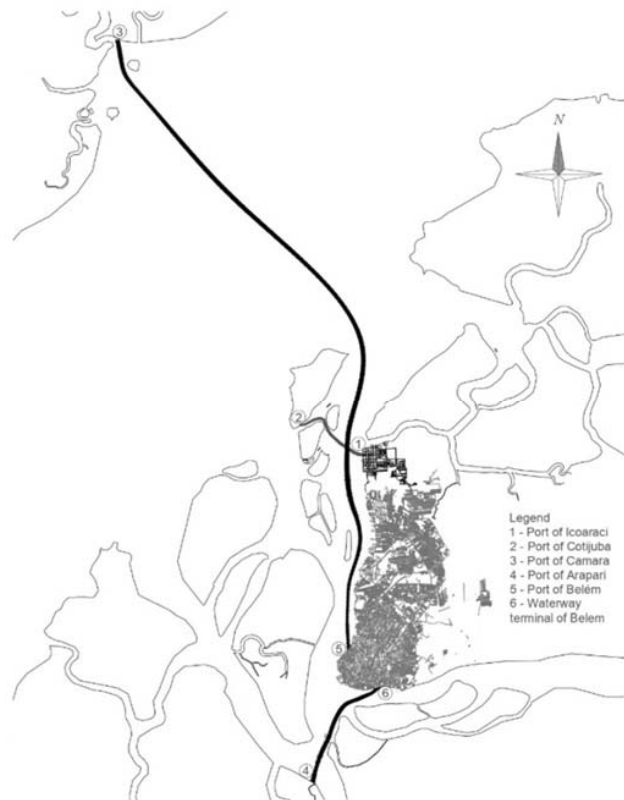


Fig. 2 Map of waterways routes

The empirical analysis of the activities that support the crossings had the following steps.

A. Definition of Cost Objects and Identification of the Activities

In this step, cost objects were identified: the crossing and the trips, by the existing equipment, for passengers and vehicles, opting in this consider only the crossing as the cost object. In the sequence, the elements of the value chain - activities - were determined (as shown in Table I). Activities were classified as primary operational or supplementary (linked directly to the cost object) and secondary activities.

B. Definition and Determination of Cost Drivers for Each Activity

The resource costs consumed by the activities were identified and determined. Company information was obtained from the financial statements for 2017, 2018 and 2019 – as shown in Table II. The resources were then grouped by cost object and categories according to their nature, namely human resources, infrastructure, equipment, and

miscellaneous resources. The human resources encompassing (technical and administrative services) were categorized into operational and administrative labor. the operation's employees and the administration's employees into operational and administrative labor. (surveillance, cleaning, electricity, maintenance at

TABLE I
ACTIVITIES AND RELATED RESOURCES

1. Primary Activities		
1.1. Operations		Indirect Costs
1	Administrative support at the port	Wages with charges
2	Ticket Sales (ticket manufacture/refund/distribution and card costs)	Ticket office salary/programs and systems/box office rental/ticket printing
3	Release of the fleet and crew (equipment preparation and crew scale)	Dispatcher
4	Fleet maintenance (personnel/storage and equipment)	Mechanical (with charges)/spares parts
5	Equipment operation (inputs and crew)	Fuel/lubricant/wage/boat rental
6	Equipment operation (depreciation)	5% p.a. of the market value of the equipment
1.2 Marketing and Sales		
1	Advertising	Annual Amount
2. Support Activities		
1	Maintenance of the company headquarters	Port infrastructure expenses
2	Administrative Activities	Lawyer/Administrative Staff
3	Accounting and Finance Services	Accounting advice
4	Other Activities	Pro-Labore Board

TABLE II
COMPANY FINANCIAL STATEMENTS IN 2017, 2018, 2019, US\$

Crossing (1)	2017	2018	2019
Total Revenues	1,157,970.31	1,102,103.96	1,108,597.06
Sales	1,157,970.31	1,102,103.96	1,108,597.06
Subsidies	-	-	-
Total Costs*	1,220,290.34	1,308,634.83	1,194,522.79
Depreciation	71,942.45	68,345.32	64,928.06
Interest and amortization	101,673.87	112,243.53	101,673.87
EBT**	- 62,320.03	- 206,530.87	- 85,925.73
Number of passengers	by ship 121,449 by boat 40,161	151,521 37,887	135,391 30,266
Crossing (2)	2017	2018	2019
Total Revenues	859,482.17	940,563.16	1,437,977.05***
Sales	859,482.17	940,563.16	1,437,977.05
Subsidies	-	-	-
Total Costs*	757,498.97	840,222.06	844,161.86
Depreciation	47,961.63	45,563.55	45,443.65
Interest and amortization	71,171.71	78,570.47	71,171.71
EBT**	101,983.19	100,341.10	593,815.19
Total of vehicles-type****	5,436	4,542	8,148
Crossing (3)	2017	2018	2019
Total Revenues	370,414.22	380,297.36	357,979.85
Sales	173,055.29	185,101.49	185,068.92
Subsidies	197,358.94	195,195.88	172,910.93
Total Costs*	335,679.28	363,816.59	343,397.78
Depreciation	11,990.41	11,390.89	10,821.34
Interest and amortization	30,502.16	33,673.06	30,502.16
EBT**	34,734.94	16,480.77	14,582.07
Number of passengers	by ship 196,759 by boat 60,276	194,320 61,977	186,178 59,530

* This table was elaborated considering accounting data provided by the studied company. Crossings: (1) – Belem – Camara; (2) – Belem – Arapari; (3) – Belem – Cotijuba. ** Excluding depreciation, amortization and interest. *** Earnings Before Taxes **** There was a significant change in the operation, due to traffic diversion to an alternative road route (30%), due to the fall of a bridge. ***** The crossing is only for vehicles with passengers or loads, with capacity for 50 vehicles-type on average.

Infrastructure costs include expenses with the company headquarters (warehouse, water, energy, indirect taxes, etc.), the ticket sales counters and the port infrastructure for the

crossing of vehicles, being the passenger terminal the responsibility of the public authorities. The resources with equipment are related to the equipment used in the crossings,

as well as computers, printers and other. Finally, in October 2014, November 2014, and February 2015, there are resources such as software and contract services, as well as occasional costs with service providers. The analysis of documents (particularly financial information) and on-site observations, and the interviews that were performed, allowed the identification of the most relevant costs and respective cost drivers having as main resource cost drivers the fuel consumption and, for the cost driver of most of the activities, the nautical miles that, in this case, allocate labor costs excessively.

C. Determination of Costs for each Activity per Crossing, considering the cost driver of most of the activities

Once the activities were defined, they were allocated to the cost objects at each crossing, as shown in Table III. It is important to point out that transport service operation activity asks for a considerable amount of fuel and labor costs. The predominant cost driver for these activities are the nautical miles. The study, then, focused on operational primary activities. However, the knowledge of supplementary and secondary activities made it possible to analyze the importance of these cost elements in the value chain and their representativeness in the total cost of the service.

Table 14, November 2014, and February 2015 shows the rates of operating costs by primary activities per mile. The total cost of activities, in this case nautical miles, was obtained from the distance in miles of each crossing multiplied by the number of annual trips. The fee reflects the cost per mile per activity in each crossing per passenger for crossings 1 and 3 or, per vehicle, in the case of crossing 2.

D. Economic Model Definition

The economic model was developed from the first moment of the research project, as well as the general characterization of the operational system of crossings, where there are other companies involved, under an oligopolistic industry arrangement. Such companies operate in a time-sharing system, using their own equipment. Except Cotijuba, where informal carriers of equipment are making the operation, with capacity for 20 passengers, being in large quantity and operating between the schedules of the ship under study. However, this competitive situation also compares to the oligopoly regime, where a competing cooperative brings together all the vessels.

TABLE III
ACTIVITIES COSTS PER CROSSING/YEAR, US\$

Activities	2017			2018			2019		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1.1.1	78,635.54	55,044.89	23,590.67	70,478.22	49,334.75	21,143.46	76,136.60	53,295.62	22,840.98
1.1.2	72,554.65	71,640.43	47,568.34	74,232.43	78,305.18	47,856.11	72,554.65	83,128.20	47,568.34
1.1.3	20,287.77	2,949.64	1,223.02	20,863.31	2,949.64	1,223.02	20,287.77	2,949.64	1,223.02
1.1.4	112,043.31	73,914.18	38,006.86	114,596.08	71,564.88	46,588.16	112,043.31	132,483.45	38,006.86
1.1.5	675,771.17	333,747.10	146,859.56	766,025.06	411,062.62	162,066.58	650,488.55	380,502.11	154,666.66
1.1.6	71,942.45	47,961.63	11,990.40	68,345.32	45,563.55	11,390.88	64,928.06	45,443.64	10,821.34
1.2.1	4,654.68	941.72	605.03	2,955.40	960.86	613.23	4,745.32	1,005.17	632.23
2.1	91,074.88	6,508.39	28,791.36	94,456.17	73,553.96	35,355.39	91,074.88	73,384.17	29,251.79
2.2	52,874.34	37,012.03	15,862.23	52,249.98	36,574.98	15,674.99	48,789.01	34,152.30	14,636.70
2.3	1,589.93	3,179.85	1,589.92	1,589.93	3,179.86	1,589.92	1,589.93	3,179.85	1,589.92
2.4	112,394.01	69,121.85	33,172.16	112,778.19	70,351.64	33,295.61	118,402.70	81,671.24	34,571.17

Crossings: (1) – Belem – Camara; Travessia (2) – Belem – Arapari; Travessia (3) – Belem – Cotijuba

TABLE IV
COST DRIVER, OUTPUT MEASURES AND TAXES, PER YEAR, US\$/MI

Activities	2017			2018			2019		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1.1.1	1,94	1,80	1,59	1,74	1,69	1,43	1,90	2,26	1,55
1.1.2	1,79	2,35	3,21	1,83	2,69	3,24	1,81	3,52	3,24
1.1.3	0,50	0,10	0,08	0,51	0,10	0,08	0,51	0,12	0,08
1.1.4	2,76	2,42	2,56	2,82	2,46	3,16	2,80	5,61	2,59
1.1.5	16,67	10,93	9,90	18,86	14,12	10,99	16,24	16,10	10,53

Crossings: (1) – Belem – Camara; Travessia (2) – Belem – Arapari; Travessia (3) – Belem – Cotijuba

The transportation system is regulated by the government and has some cost items, such as labor remuneration set by the Navy, as well as the government regulates the tariff. In other words, the margin for cost adjustments lies on the optimization of resources used and an accurate allocation of these costs to primary operational activities, developing efficient strategies for sharing equipment and infrastructure. For example, the company under study rents a boat, mainly to cover the high season. It also shares the port of the Arapari crossing, where it operates with three other competitors. However, the shared operation is very small, and there is a climate of distrust among the operators.

The conceptual model developed is shown in Fig. 3, and it reflects the understating of the operation and of the business model obtained from observations in loco. The configuration of the service value chain presented is divided into primary activities, directly linked to the execution of the service and, secondary activities that support the execution of the service. The value chain starts from service conditions determined by the managing body, which establishes standards and operating conditions for items such as tariffs and labor usage. These conditions include the sale of tickets, the release of the fleet and the crew stopover for the trip. In secondary activities, support, we find the administrative costs and others

related to the port, where are also included the expenses with the direct costs. the company headquarters. In other activities, there are

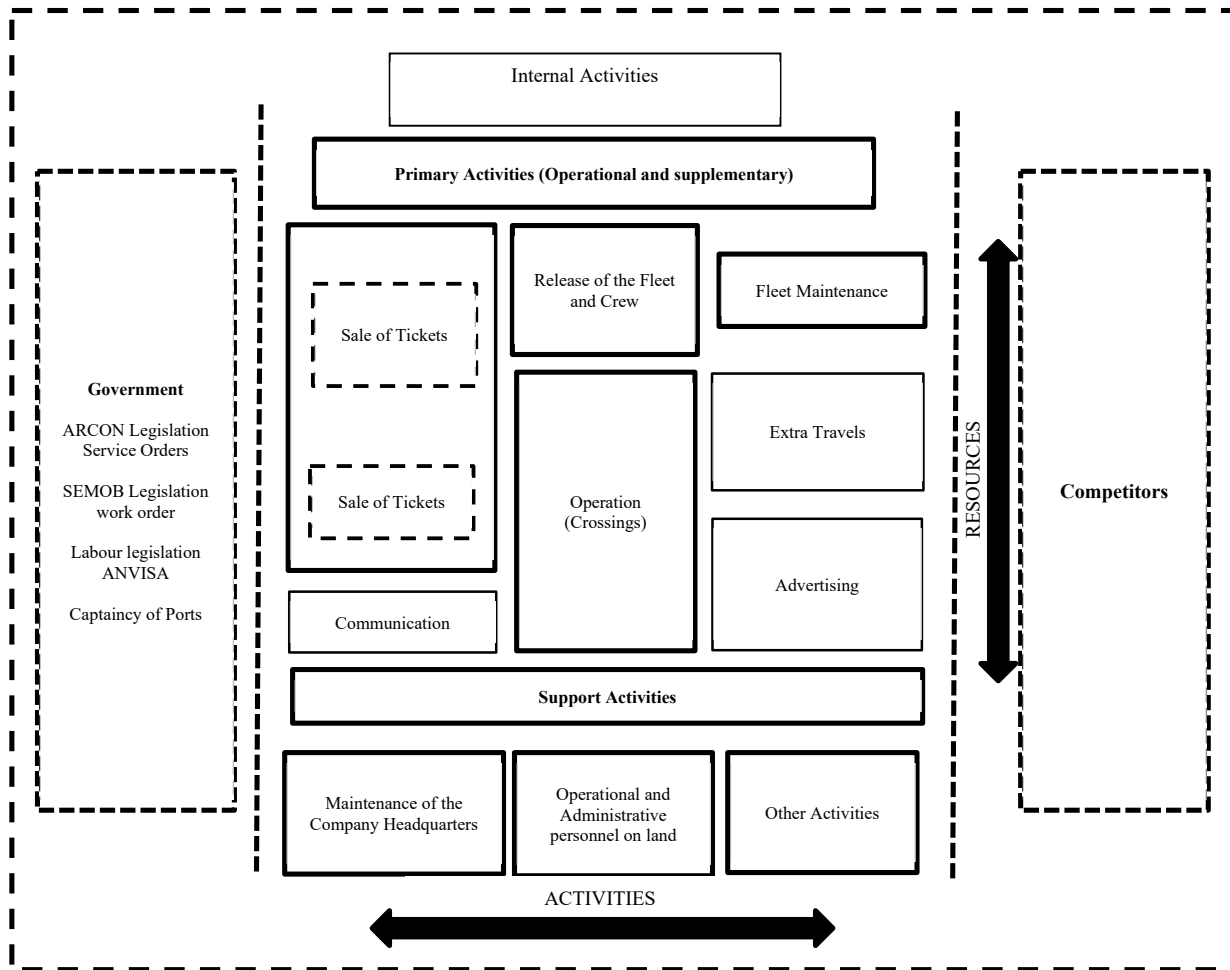


Fig. 3 Conceptual Economic Model based on the Value Chain

V.DISCUSSION

In the analysis of the data, the following constraints were highlighted:

- Financial instability of the operation, resulting from competition and management difficulties: the three crossings have different economic results (as shown in Table II), in which the first crossing, Belem-Camara, has been showing an annual deficit for three consecutive years. The second crossing, Belem-Arapari, contrary to the first one, shows a positive balance in recent years. However, there is a kind of cross-subsidy between the two, in which the profit of the first crossing is absorbed to cover the deficit of the second one, but it is not sufficient. This has led the company to take out regular loans to cover losses. Revenues from the two crossings show some annual regularity, with the Arapari crossing showing a significant increase in revenues in 2019, due to the increase in traffic, resulting from a bridge that fell, which is expected to open in early 2020. In other words, everything indicates that the 2020 profit and loss statement should return to average values around the 2017 and 2018. Cotijuba's condition is the most stable; it has the fact of being the only official operating company of the crossing, being affected by informal ones, without the same business scale. As for the competition, considering that according to the company, the occupation of the equipment is only reached in two months of the year, it can be noticed that in the remaining months there is a surplus of supply, presenting together with its competitors a financial deficit;
- Fuel consumption and labor are the cost drivers of the resources employed in the operation of the crossing service, and the operation activity, named 1.1.5, is the one that consumes the most portion of the resources. The fleet maintenance activity is the second most important activity in the company's costs, which indicates the need to reassess the routine of fleet maintenance procedures. In the administrative activities, it was observed that other activities are made up of various expenses that need to be reevaluated by the company, being mostly indirect costs of the production of the service;
- The cost of the primary activities of the Belem-Camara and Belem-Arapari crossings are driven by nautical miles, which, in turn, has as critical activities the performance of the crossings (operation costs) and fleet maintenance. In addition, the administrative support activity at the port proved to be costly in 2019, due to the diversion of traffic. The Belem-Cotijuba crossing

showed stable results, being a crossing that is impacted by competition and the seasonality is lower, as it meets the residents of Cotijuba Island, maintaining a constant demand, as can be seen in Table II. However, it was observed a high cost rate of the ticket selling activity, in relation to the other crossings, perhaps because of the obligation to operate separately, and thus, the allocation of this activity to the cost object (crossing) is high;

- The economic model is based in an oligopoly in a regulated environment with little margin for negotiation: the service is regulated and in the competitive environment by the managing body, which defines the price of the service, is approved remuneration. The company has primary and secondary activities to perform the service conditioned by laws, rules and regulations controlled by several agencies. Competitors face similar regulations and the same market conditions. Thus, competitive advantage can be achieved through more optimized activities, higher quality of the service, and better marketing and communication than the other companies that operate in the region.

VI. CONCLUSION

The use of the ABC methodology proved to be useful for the understanding of the costs of the crossings, being possible to identify the main activities and their costs and to validate with the company the results obtained from the analysis of the annual financial statements.

The analysis showed that the seasonality of the service is a constraint that requires an effective marketing and a good cost management strategy, in order to attract the maximum demand in high season periods and cover the periods of low season in a sustainable way. In addition to seasonality, the company faces competition, which further contributes to an over-supply of the service, contributing to the existence of an operational deficit. In addition, this deficit is due to the tariff gap, because the tariff has not been readjusted during the entire period under analysis.

The activities that demand more resources are those of an operational nature - operation and maintenance. Furthermore, administrative costs need to be reviewed in order to be less impacting in the service costs. These costs can be renegotiated and even eliminated in order to give space to more direct costs, which may contribute to a higher quality of the service and, consequently, minimizing the financial deficit of the crossings.

Finally, the existing business model asks for partnerships and collaboration among competing companies, mainly in terms of secondary activities. Indeed, several costs can be reduced if the infrastructure and onshore labor (port and maintenance) are shared. Furthermore, there are economies of scale to be explored in the acquisition of resources particularly, fuel. But, to do so, the business environment would have to be improved, making it more professional and establishing a relationship of greater trust and collaboration among operational partners.

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