

The Impact of Management Accounting Costing Methods on Supply Chain Management

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Abstract:

Increasing of global competition are shaped by firms with due emphasis on product quality and low costs. The conceptual framework for management accounting tools became appropriate in the framework of supply chain management. In spite of the fact that the border between supply chain management and the methods of management accounting costs have been faded. Strictly speaking, almost techniques of cost of management accounting are established in the context of supply chain management. With this background, several costing techniques for firms have been viewed and with evaluating these techniques, a conceptual framework for management accounting tools in a supply chain will be developed.

Keywords: Supply Chain Management, Cost Techniques, Activity Based Costing, Target Costing and Total Cost of Ownership.

ملخص:

نظرا للمنافسة العالمية المشهودة من قبل المؤسسات من خلال التركيز على جودة المنتجات والتكاليف المنخفضة، فقد أصبح الإطار المفاهيمي لتقنيات تسيير التكاليف مناسب جدا لإدارة سلسلة التوريد، ولم تعد هناك حدود بين إدارة سلسلة التوريد وهذه التقنيات. كما أن اغلب التقنيات قد تم تطبيقها على مستوى إدارة سلسلة التوريد. فمن خلال هذه الخلفية يمكن القول بأن التطبيق المتزايد لهذه التقنيات والتقييم المتواصل لها سيثري الإطار المفاهيمي لتقنيات تسيير التكاليف على مستوى إدارة سلسلة التوريد.

الكلمات المفتاحية: إدارة سلسلة التوريد، تقنيات التكاليف، التكاليف على أساس الأنشطة، التكاليف المستهدفة والتكلفة الكلية للملكية.

Introduction:

In the last decades, there are many researches on supply chain management. Some authors (Christopher,1992¹; Ballou,2004²;Hoole,2005³).Manage of supply chain helps the firm to reduce costs, improve flows and create value in order to gain

competitive advantage(Anna, 2013)⁴.In sum, supply chain management emerged in 1990's and consider as a source of competitive advantage(Jones, 1989)⁵.Anna focused on the potential role that management accounting information can play it in the context of supply chain management. Anna indicated methods that can be used in the implementing of management accounting practices to facilitate effective supply chain management (Anna, 2013)⁶.

It is worth mentioning, that Ellram, indicated performance measures as a key of successful cost management in the supply chain (Ellram, 2002)⁷.There is thus a need to cost based performance measure in supply chain management. As we know managers in business agree that cost analysis has utmost importance in the firm's management. Especially, when we talk about analyzing the supply chain for cost-saving opportunities, in this case we require the ability to measure, analyze, state describe or define exactly the nature, scope, or meaning of costs among channel of supply chain.

In this research we concentrate on one aspect is the impact of management accounting costing methods on supply chain management. There are some researchers who have been developed conceptual models for techniques of cost accounting in supply chains. These researchers gave us previous researches summaries on some technique of cost of management accounting. LaLonde and Pohlen made a question about the tools available for effectively costing an extended supply chain and the most effective costing method to improve competitiveness and profitability (LaLonde and Pohlen, 1996)⁸. The main operational goal of supply chain management is to minimize costsb (Mouritsen et al., 2001)⁹.

Therefore, use a new strategic supply chain requires changes in the management of supply chain cost as well as for the optimization of some processes (Seuring, 2009)¹⁰.In this case, the managers are responsible for any cost consequences of any supply chain changing (Cooper and Slagmulder, 2004)¹¹, because of the practical relevance of cost accounting in supply chain management.

Thus, this research approach focuses on the possibilities and limitations inherent in technique of costs of management accounting methodology for supply chain management, and their impact on supply chain. Therefore the research question can be formulated as follows:

What is the impact of management accounting costing methods on supply chain management?

This leads to the following structure of the paper, which contain tow major parts:

- The concept of supply chain management;
- Some technique of cost management accounting.

This paper concludes with a critical reflection on the findings by discussing the chances, opportunities and limitations of applying cost techniques of management accounting on firm's supply chain.

I- The concept of supply chain management :

Over the past few decades, supply chain management became one of the key factors of competitive advantage (Porter, 1985)¹². Accordingly, we will speak in this section about definition of Supply Chain management, Supply Chain Management Elements and Objectives of Supply Chain Management.

1- Definition of Supply Chain management:

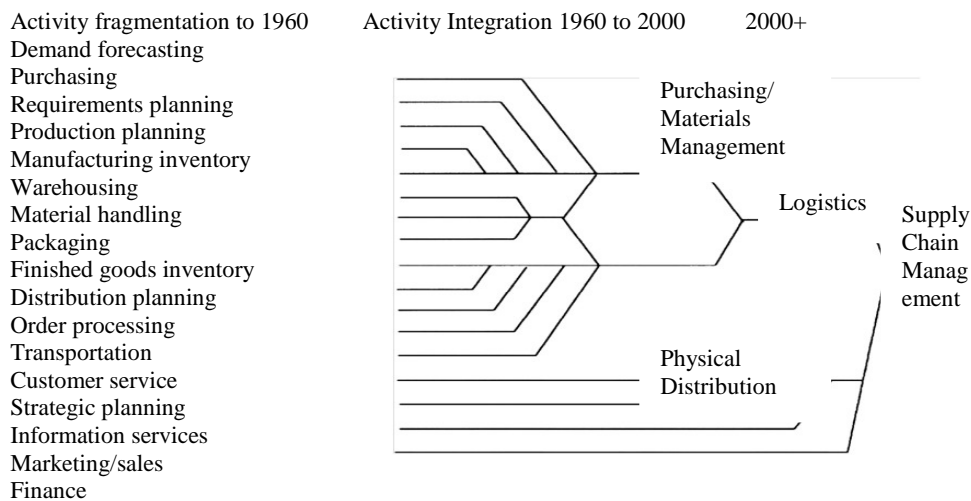
In the literature, there are various definitions of supply chain management. The definition of Handfield and Nichols is the commonly used. This definition is: “the supply chain encompasses all activities associated with the flow and transformation of goods from the phase of acquisition of materials, through successive stages up to the end user, as well as activities associated with the

flow of information. Resources and information are moving up and down the supply chain. Supply chain management is the integration of these activities through the improvement of supply chain relationships in order to achieve competitive advantage”. (Handfield and Nichols, 1999)¹³.

We think that this definition focused on two essential elements, namely first that all activities must be integrated, and second that used this integration to achieve competitive advantage. This management trend focused on all the activities and must integrated in order to get more of feature that make a company in good place in the market and manage the relationship between company with their suppliers and customers. All of these steps are to get and achieve competitiveness.

Over the last decades, Supply Chain Management has seen many of evolutions, and we will show the evolution of Supply Chain Management as follows:

Figure1: The evolution of supply chain management



Source : Ballou R.H. The evolution and future of logistics and supply chain management. European Business Review 2007, 19 (4), 332–348.

It's necessary for logistics managers have repeatedly required the capability to isolate logistics costs by function, territory, commodity, channel, method of sale, class of trade, order size, operating or product divisions, delivery method, terms of sale and improve relationship between producers with their suppliers and customers...etc. (LaLonde and Pohlen, 1996)¹⁴.

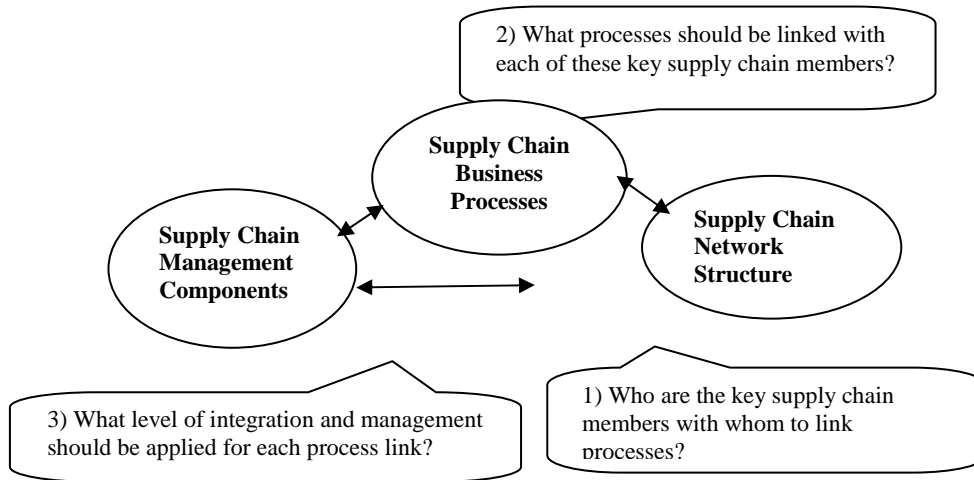
2- Supply Chain Management Elements :

In few recent decades, this trend in management has increased widely. The reason of this increasing is a company concentration on creating competitive advantage by minimizing costs and improve the quality of services by using new management tools as supply chain management.

The trend of SCM must have elements to give more understanding or a conceptual framework about Supply Chain Management. The conceptual framework must contain three major and core elements (as shown in figure 2):

- The supply chain network structure,
- The supply chain business processes and,
- The supply chain management components.

Figure 2 : Supply Chain Management Framework: Elements and Key Decisions



Source: Douglas M. Lambert, Martha C. Cooper and Janus D. Pagh, "Supply Chain Management: Implementation Issues and Research Opportunities," *The International Journal of Logistics Management*, Vol. 9, No. 2 (1998), p. 4.

In summary, all supply chain must contain these important components:

- Integration of activities ;
- Information and Processes ;
- Suppliers, producers and customers.

3- Objectives of Supply Chain Management :

Overwhelming majority basic objectives of supply chain management are:

- To reduce uncertainty and risks in the supply chain,

- Managing uncertainty, which positively affect inventory levels, quality, cycle time, processes, and eventually, end-customer service level, (chase et al., 1998)¹⁵, and,
- Satisfy all requirements of customers. In sum, these goals are important to effective supply chain management.

II- Development of cost management accounting techniques:

The complexity of the supply chain activities emerged the need to apply variety cost accounting methods in the context of supply chain management, especially the newest. These methods are able to gain sustainable competitive advantage .So, this section comprises some technique of cost management accounting that applied in the context of supply chain management. These techniques have been tested in previous case studies.

Newer costing techniques such as total cost of ownership and activity based costing have provided useful information (LaLonde and Pohlen, 1996)¹⁶.

Management accounting techniques able to provide information which give more collaborations for supply chain management (Ellram,L.M., 2002)¹⁷. Various cost management accounting techniques focus on activities and processes along the supply chain management. In sum, management accounting is able to help greatly in inventing a new ways or methods for supply chain activities.

In fact there are some gainful techniques in the process of supply chain management, for example the Target Costing, Activity Based Costing and Value Chain Analysis.

1- Activity Based Costing:

In doing so, Many of considerations are based on Activity Based Costing as a cost management tool or technique (Askarany and Yazdifar, 2011)¹⁸.

Many application of Activity Based Costing have been excessively discussed and it could consider as one of the most important techniques for enhancing Supply Chain Management in organizations(see Wouters, 1994¹⁹; Gunasekaran and Sarhadi, 1998²⁰; Thyssen et al., 2006²¹; Singer and Donoso, 2008²²; Askarany and Yazdifar, 2011²³), and gave us a describing how activity based costing can applied along supply chain management and many of studies highlighted on how ABC tools managed costs effectively and efficiently in the context of supply chain management, in order to provide advantages.

Furthermore, Schulze.M et all discussed Activity Based Costing models and found that these models give important considerations. They taking in account an effective and efficient network, setting up of production activities outside their scope along the supply chain management and form a one of many kinds of approaches and do not deal with how do the integration and the comparison of different company accounting standards in one Activity Based Costing model (Schulze.M etall., 2012)²⁴.

However, one of the important methods of management accounting costing can we found it in the framework of the supply chain management is Activity Based Costing and it considered as one of the dominant perspectives (Seuring, Goldbach, 2002)²⁵. This point of view highlighted more and more on the importance of the relationship between this technique that called Activity Based Costing and this trend of management so-called Supply Chain Management.

Despite the above, suppliers can provide additional services which are identified by Activity Based Costing, as examples, the product design and development which gave multiple values to the final product and contributed in internal costs reduction by suppliers. (Ramos M.M., 2004)²⁶.

Dekker and Van Goor presented a case study of supply chain in the Dutch pharmaceutical industry, and they made calculations of Activity Based Costing (as shown in Figure 3). They made a model to support decision along supply chain activities (Dekker and Van Goor,2000)²⁷.

Figure 3: The ABC Model (in Euros)

	Producer	Wholesaler	Retailer	Chain
Purchasing				
Ordering	–	170,500	10,485	180,985
Receiving	285,500	551,900	16,439	853,839
Total	285,500	722,400	26,924	1,034,824
Warehousing				
Stock keeping	–	486,400	73,288	1,130,988
Bulk Goods	256,000			
Picking Goods	315,300			
Inventory	584,400	734,600	–	1,318,600
Total	1,155,300	1,221,100	73,288	2,449,588
Outbound				
Outbound Goods	–	1,239,400	1,450	1,240,850
Retail	512,000			
Wholesale	583,000			
Expedition	610,000	940,300		1,550,300
Reverses	205,000	102,000		307,000
Total	1,910,000	2,281,700	1,450	4,193,150
Total Logistic	3,350,800	4,225,100	101,662	7,677,562

Dekker and Van Goor calculated costs along the supply chain activities in order to decrease of the entire supply chains

costs. They compared directly the costs of some activities in the context of the supply chain management. Furthermore Dekker and Van Goor analyzed the changes effects in activities which effect on costs increasingly, this case study shows how use ABC method to support SCM decision.

Furthermore, the major role of ABC is to control costs effectively and efficiently. Thus give more understanding in reducing costs, estimating costs and measuring performance. We found that Activity Based Costing is useful to support decision making in the context of supply chain management. Indeed, the use of ABC includes performing a number of different activities along supply chain management.

ABC system tries to allocate costs to all activities, processes and organization products, services and customers. ABC highlighted on the activities and provides important information in the coordination of the activities in the supply chain (Anna, 2013)²⁸. This also proved that the extent of the importance of cost data in the context of SCM. Thus, need to take in account all information as well as the integration between ABC and SCM will increase widely in future research. In other hands, the integration between SCM and ABC helps to reduce costs, estimate cost and measure performance in organizations.

2- Target Costing (TC) :

Target Costing is one of the principal tools of cost management accounting which is found in the framework of the supply chain management. Target Costing considered as one of the prevailing perspectives as activity based costing in order to set and achieve the goals (Seuring and Goldbach, 2002)²⁹.

One of the most definitions that used in literature is given by (Ellram, L.M. 2000)³⁰. This definition as follow “Target costing is a process whereby an organization develops specific goals, or targets,

for its costs to produce a good or service. The target costs are based upon desired profit margin and projected selling price for the good or service, and reasonable estimates of what the item or service should cost”.

Target Costing can be considered as a process which developed to support and to enhance strategic cost management according to three elements that proposed by (Shank and Govindarajan., 1993)³¹. These elements are:

- Competitive positioning analysis,
- Cost driver analysis and,
- Value chain analysis.

There are three main processes of target costing (Ramos M.M., 2004)³²:

- Deciding on the features of the product or service and estimating its selling price from them ;
- Establishing the desire profit target and then calculating the target cost ; and
- Achieving the previously established target cost.

Looking at the main advantages of target costing addressed in the previous literature, which can provide us with some evidence and indicators to make and to use the best proposition in terms of the expected relationship between the adoption of target costing method and organizational supply chain management.

Ellram gave six steps of target costing process as follows³³:

- **Step 1:** Product or Service Characteristics Identified;
- **Step 2:** Establish Target Selling Price;
- **Step 3:** Determine Target Cost Target Cost = Target - Target Selling Profit Price;

- **Step 4:** Cost Breakdown to Detailed Level of Component/Service;
- **Step 5:** Cost Management Activities May Include: Supplier Development, Design Change, Material Change, Specification Change and Cost Trade –off;
- **Step 6:** New Product/Service Roll-out and Continuous Improvement Efforts;

Ellram examined the relationship between target costing and SCM based on case studies of six firms. The case study showed the contribution or the major role of supply management during major target costing activity (as shown in Figure 4). The process of target costing gives a substantial role to supply chain management (Ellram, L.M. 2002)³⁴.

Figure 4: Contribution of supply management during major target costing activity

Target Costing	Role/Involvement	Peripherals	Semi	Electronic	Computer	Aerospace	Auto
A11	Dedicated "new product/service" buyers without daily purchasing responsibility		X	X			X
15	Maintain close working relationship between buyer and design/R&D	X	X	X		X	X
1	Identify capable suppliers	X	X	X		X	X
1	Facilitate early supplier involvement	X	X	X		X	X
1	Qualify suppliers or ensure only qualified suppliers are selected	X	X	X	X	X	X
4	Negotiate with suppliers	X	X	X	X	X	X
5	Develop long-term contracts/agreements with suppliers	X	X	X		X	X

4	Developsuppliercostestimates	X	X	X	X	X	X
4	Getsuppliercostbreakdownswherpossible	X	X	X		X	X
5	Workwithsuppliersoncostreductionideas	X	X	X	X	X	X
5	Suggestchangestotargetcost	X	X	X			X

Ellram found that the application of target costing is useful for the firms, especially, the application of this technique in the context of supply chain management. This application leads the firms to more control of many costs along supply chain which give more competitive advantages.

Moreover, the reason for Target Costing is the increasingly usefulness of these techniques to give more disclosure and understanding about costs, enhance cost reduction and know about these continuous improvement and competitiveness, improved communications, early involvement, improved design and accountability in the context of supply chain management (Ellram, L.M. 2000)³⁵.

3- Total Cost of Ownership (TCO) :

There are many definition of Total Cost of Ownership. Among the commonly used is the definition formulated by (Ellram 1994a)³⁶ as follows “an innovative philosophy aimed at developing an understanding of the “true” cost of doing business with a particular supplier for a particular good or service”

Total Cost of Ownership is a method that analyzes and classifies acquisition costs or is structured method helps to understand the total cost compatible with acquisition and use of a given item, goods or services during their life cycle.

According to the Total Cost of Ownership literature, the main benefit/advantage of Total Cost of Ownership as a new

technique of management accounting over traditional cost accounting techniques is related to its ability in providing more accurate cost information, especially, about suppliers, purchasing and buyers, which give more understanding about how manage supply chain.

Total Cost of Ownership method helps to establish and manage relationships between the supply chain participants effectively and efficiently. TCO used to identify and support potential opportunities for improvement, enhancing and promotion coordination and learning between parties along the supply chain. A buyer perspective is the element that the investigation was about it in the literature of Total Cost of Ownership.

Paulo presented a case study in an OEM of the Automotive Industry through using Total Cost of Ownership for Supply Chain Management. Paulo used TCO method for three different situations (as shown in figure 5)³⁷.

Figure 5: Cost items proportion on total cost

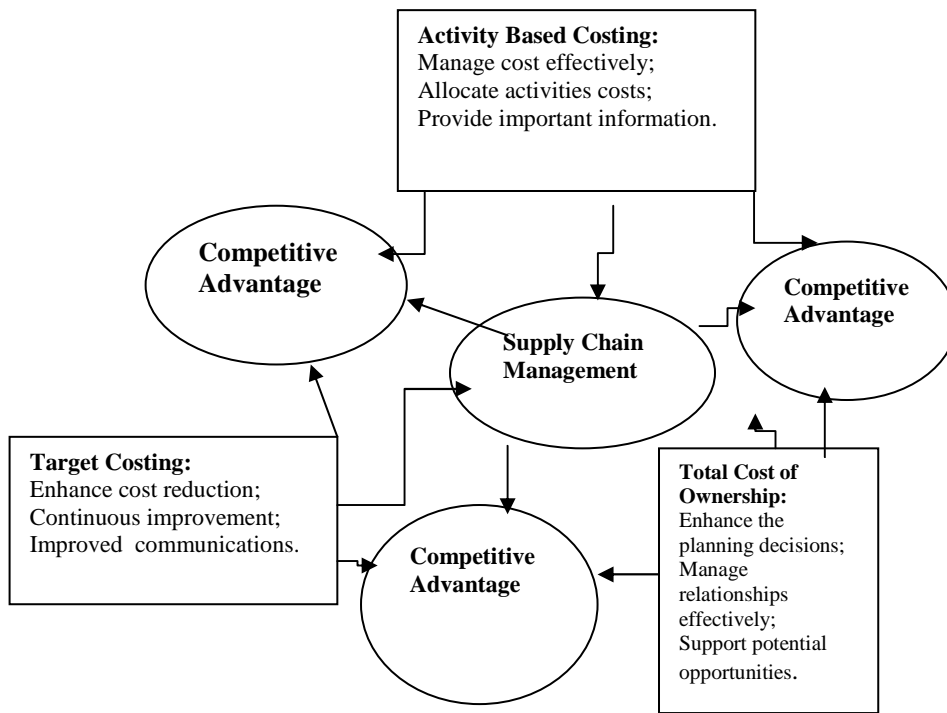
Costitens	Case1	Case 2	Case 3	Average
Acquisitioncosts	50.2	44.1	72.3	55.5
Package costs	0	0	0	0
Toolcosts	43.4	54.1	14.5	37.4
Transportcosts	1.5	0.1	5.7	2.4
Inventorycosts	3.0	1.0	5.7	3.3
Nominationcosts	0	0	0	0
Qualitycosts	1.8	0.6	1.7	1.4
Othercosts	0	0	0	0
Total	100	100	100	100

This case study gave more understanding about transactions with suppliers, purchasing price, negotiation and looking for the best suppliers and distinguishing between them. These case studies found that the supplier with the lowest TCO was showed a lower purchase cost.

Total Cost of Ownership helps to make a comparison from others suppliers, pricing and other decisions, because the TCO enhance the planning decisions (Ramos M.M., 2004)³⁸. Especially, Total Cost of Ownership is an important method within the supply chain management, it is an effective and efficient way to follow the hidden indirect costs relating to transactions that are with suppliers, especially, that purchasing processes are considered to be related strategically (Anna, 2013)³⁹.

In sum, effective supply chain management gives competitive advantage and effective management accounting techniques give competitive advantage too. So, when we use both of them in organizations we will able to gain competitive advantage, especially, when we talk about these techniques: Activity Based Costing, Target Costing and Total Cost of Ownership. These techniques are appropriate for supply chain management and we found that all of them minimize costs in order to gain competitive advantage.

Figure 6: The Impact of Management Accounting Costing Methods on Supply Chain Management



Proposal figure

The important task of managers is to highlight new methods of management accounting in the context of supply chain management in order to achieve supply chain cost efficiency, create a value for supply chain and of utmost importance task is to gain competitive advantage. It is to be noted, however, that not all firms can pursue costs on an entire firms. In the fact that the use of management accounting costing methods is useful to manage costs. The application of these methods in the context of the supply chain management has been regarded as one of the key factors of competitiveness by many researchers.

Conclusion:

Management Accounting Cost Techniques helps to estimate costs, reduce costs, know more and more about costs and know how control costs. Strictly speaking, Activity Based Costing, Target Costing and Total Cost of Ownership have been recognized as important tools for lowering, controlling and estimating the real costs over last few decades.

In recent years, based on cost techniques of management accounting in the context of supply chain management are developed and aimed to rationalize of business management, as well as the integrated supply chain management. In sum, supply chain management emerged in 1990's and consider as a source of competitive advantage which enhance organizational performance, improve production quality and give more and more of profitability.

Cost based analysis should be viewed as an ongoing initiative incorporated into a conceptual framework within supply chain management. Many of these considerations are based on use of these techniques as a tool to manage the costs. Thus, the result of the impact of management accounting costing techniques on supply chain management as follows:

- The need of relationships integration with suppliers and customers in the context of supply chain management.
- Develop management accounting costing techniques to treat the new information that lead to decision making.
- Control, follow and reduce costs along supply chain.

Activity Based Costing, Target Costing and Total Cost of Ownership as the techniques of cost of management accounting play a core role in the context of Supply Chain Management. Organizations using techniques of management accounting as

Activity Based Costing, Target Costing and Total Cost of Ownership for a variety of reasons. The major reason may be increasingly classified as the need to increase competitiveness by not just reducing costs but also improving understanding of the cost structures, must focus increasingly on customer satisfaction, improve quality of products, increase communication, trying to treat all information effectively, focus on supplier involvement in a new product or service development process and follow all activities, especially when we talk about supply chain in the organizations.

Manage of supply chain helps the firm to reduce costs, improve flows and create value in order to gain competitive advantage and we found that the new management accounting costing methods focus on operations and processes. Substantially, the need of these costing methods increased because of the new information that drive to new objectives and require implementing new management accounting costing techniques. Subsequently, management accounting costing techniques has an effective role in the field of improving competitive advantage by enhancing supply chain management processes and operations. In summarize, these management accounting costing techniques, Activity Based Costing, Target Costing and Total Cost of Ownership are acceptable and suitable for supply chain management. We found that all of them minimize costs in order to gain competitive advantage.

References

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- ¹ Christopher, M., Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Services. Pitman Publishing: London, 1992.
² Ballou, R.H., 2004. Business Logistics /Supply Chain Management: Planning, Organizing, and Controlling the supply Chain, 5ed. Pearson Prentice-Hall, Upper Saddle River, NJ.
³ Hoole, R., 2005. Five ways Simplify Your Supply Chain Supply Chain Management: An International Journal.

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- ⁴ Anna, Surowiec., 2013. Costing methods FOR Supply Cahin Mmanagement, 1st Annual International Interdisciplinary Conference, AIIC, 24-26 April, Azores, Portugal.
- ⁵ Jones, C., 1989. Supply chain management – the key issues. BPICS “Control”, October/November, 23–27.
- ⁶ Ibid.
- ⁷ Ellram, L.M., 2002. Strategic cost management in the supply chain: A purchasing and supply management perspective. CAPS Research.
- ⁸ LaLonde, B.J., Pohlen, T.L., 1996. Issues in supply chain costing. *The International Journal of Logistics Management* 7 (1), 1–12.
- ⁹ Mouritsen, J., Hansen, A., Hansen, C.O., 2001. Inter-organizational controls and organizational competencies: episodes around target cost management/functional analysis and open book accounting. *Management Accounting Research* 12 (2), 221–244.
- ¹⁰ Seuring, S., 2009. The product-relationship-matrix as framework for strategic supply chain design based on operations theory. *International Journal of Production Economics*, 1–12. doi:10.1016/j.ijpe.2008.07.021.
- ¹¹ Cooper, R., Slagmulder, R., 2004. Inter-organizational cost management and relational context. *Accounting, Organizations and Society* 29 (1), 1–26.
- ¹² Porter M. E. *Competitive advantage*. New York: Free Press, 1985.
- ¹³ Handfield, R. B., Nichols E. L. *Introduction to Supply Chain Management*. New Jersey: Prentice Hall, 1999.
- ¹⁴ Ibid.
- ¹⁵ Chase, R.B., Aquilano, N.J., Jacobs, F.R., 1998. *Production operations management, manufacturing and services*, eighth ed. Irwin/McGraw Hill, Boston.
- ¹⁶ Ibid.
- ¹⁷ Ellram, L.M., 2002. supply management’s involvement in the target costing process, *European Journal of Purchasing & Supply Management*, Vol. 8, pp. 235-244.
- ¹⁸ Askarany, D., Yazdifar, H., 2011. An investigation into the mixed reported adoption rates for ABC: evidence from Australia, New Zealand and the UK. *International Journal of Production Economics*. doi:10.1016/j.ijpe.2011.08.017.
- ¹⁸ Wouters, M.J.F., 1994. Decision orientation of activity-based costing. *International Journal of Production Economics* 36 (1), 75–84.
- ¹⁹ Ibid.
- ²⁰ Gunasekaran, A., Sarhadi, M., 1998. Implementation of activity-base costing in manufacturing. *International Journal of Production Economics* 56–57 (1), 213–242.

-
- ²¹Thyssen, J., Israelsen, P., Jorgensen, B., 2006. Activity-based costing as a method for assessing the economics of modularization—a case study and beyond. *International Journal of Production Economics* 103 (1), 252–270.
- ²²Singer, M., Donoso, P., 2008. Empirical validation of an activity-based optimization system. *International Journal of Production Economics* 113, 335–345.
- ²³Ibid.
- ²⁴M. Schulze et al., 2012. Applying activity-based costing in a supply chain environment / *Int. J. Production Economics* 135, 716–725.
- ²⁵Seuring S., Goldbach M. *Cost Management in Supply Chains*. Heidelberg: Physica-Verlag, 2002.
- ²⁶Ramos, M.M., 2004. Interaction between management accounting and supply chain management. *Supply Chain Management: An International Journal*, 9 (2), 134–138.
- ²⁷Henri C. Dekker., Ad R. Van Goor., 2000 *Supply Chain Management and Management Accounting: A Case Study of Activity-Based Costing*, *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management*, 3:1, 41-52.
- ²⁸Ibid.
- ²⁹Ibid.
- ³⁰Ellram, L. M., 2000. Spring. Purchasing and supply management's participation in the target costing process. *Journal of Supply Chain Management*, 36(2), 39-45.
- ³¹Shank, J.K., and Govindarajan, V., *Strategic Cost Management: the new tool for competitive advantage*. New York: The Free Press, 1993.
- ³²Ibid.
- ³³Ellram, L.M., 1999. *The Role of Supply Management in Target Costing*. CAPS Research, Tempe, AZ.
- ³⁴Ibid.
- ³⁵Ibid.
- ³⁶Ellram, L. M., 1994a. A taxonomy of total cost of ownership models. *Journal of Business Logistics*, 15, 171-191.
- ³⁷Paulo. A., 2013. Total Cost of Ownership for Supply Chain Management: A Case Study in an OEM of the Automotive Industry *Advances in Production Management Systems, Competitive Manufacturing for Innovative Products and Services IFIP Advances in Information and Communication Technology*, Volume 398, , pp 592-599.
- ³⁸Ibid.
- ³⁹Ibid.