BENEFITS ASSESSMENT OF TRAINING ON SUPPLY CHAIN MANAGEMENT

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ABSTRACT

Supply chain management (SCM) is a critical factor in the current global scenario. This organizational capability has a recent knowledge base, which is being accumulated, validated, and certified by groups like the Association for Operations Management (APICS). Therefore, training in SCM has been growing as one of the most convenient ways of becoming "Certified in Production and Inventory Management" (CPIM) from APICS. Companies all over the world have invested in SCM training; however, some companies have conditioned the continuity of their training programs to the benefits assessment. This paper contributes by proposing an evaluation model for specific program training on SCM. This model was applied in a global chemical company, which allowed capturing its impact on organizational and individual competencies, as well as on the core competencies. The proposed model includes the Analytic Hierarchy Process (AHP) and concepts in the SCM literature. The main result revealed by this research is that an SCM training based on APICS CPIM is really perceived as beneficial, in

* **Acknowledgment: For the research presented in this work, authors received financial support from CAPES Foundation (PhD Grant) and Sao Paulo State Research Foundation (FAPESP Grant no. 2013/035257).**

individual or organizational terms, for a real-world company. Therefore, this company should be confident that its SCM training program is improving and strengthening its core competencies.

Keywords: Analytic Hierarchy Process; supply chain management; training

1. Introduction

Supply chain management (SCM) is a critical factor in the current global scenario (Hult, Ketchen & Arrelti, 2007). This organizational capability has a recent knowledge base which is being accumulated, validated, and certified by groups like Association for Operations Management (known as APICS, formerly American Production and Inventory Control Society) (Coriat & Dosi, 2002). SCM is defined as the "design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally" (Blackstone, 2013).

SCM capability encompasses multiple functions, which need to be learned over time by organizations. Training provides the opportunity to learn and accumulate these SCM capabilities that have to be mastered. These capabilities are fundamental to engage and upgrade in global value networks, which coordinate "…what is to be produced, how it is to be produced, and […] how the flow of product along the chain is to be handled" (Humphrey & Schmitz, 2002). In this context, it becomes relevant to obtain SCM certification (Tan, 2001). Therefore, training in SCM has been growing as one of the most convenient ways of becoming "Certified in Production and Inventory Management" (CPIM) from APICS. Also SCM training and CPIM contribute to the development of the field of terminology concepts and strategies related to SCM: Demand Management, Master Production Scheduling, Materials Planning, Capacity Management, Sales and Operations Planning, Production Environments and Process, Purchasing, Physical Distribution, Performance Measures, Supplier Relationships, Lean and Just-In-Time, Quality Systems and Continuous Improvement (APICS, 2015).

Since SCM certification is considered a strategic advantage in the global economy most organizations have invested in the development of SCM capabilities through training because it provides a broad perspective of the whole supply chain, its functions, its relations, and offers knowledge to understand how the overall supply chain integrates (Lummus, 2007; APICS, 2015). In fact, investment in training is also expected to enable, for instance the development of the employees' base of knowledge and skills, which is related to the improvement and mastering of SCM functions; the education of team members who interact with or support supply chain activities, helping them to increase efficiency and generate ideas for improvements; and the adoption and effective use of new information technologies; the development and improvement of SCM practices that promote effective supply chain management in dynamic environments (APICS, 2015; Tracey & Smith-Doerflein, 2001).

Companies all over the world have invested in SCM training in order to obtain certification (CPIM) from APICS. However, some companies have conditioned the continuity of their training programs to the benefits assessment.

Most traditional methodologies for assessing the investment returns for training initiatives utilize very aggregated financial and non-financial measures which do not satisfy the company´s need for more detailed information about the impacts of investments on their base of resource, capabilities and competencies (Satiman, Abu et al., 2015; Bukowitz, Williams et al., 2004). Some related approaches showed the relationship between higher level SCM practices, as well as Green SCM practices that have been learned at some point in time and performance (Zhu & Sarkis, 2004; Li, Ragu-Nathan, et al., 2006). In this direction, Cheung, Myers and Mentzer (2010) presented evidence that, "for both buyers and suppliers, relationship learning is a critical, strategic component of relationship value in cross-border exchange". In a closer approach, because they dealt with SCM training focusing on the learning dimension, Manyathi & Niyimbanira (2014) attributed problems detected at the SCM level to the need for reinforcing their SCM training program, utilizing learning theories as guidance in its design, development and implementation, so as to increase workforce competence. Thus, a research opportunity exists to develop an evaluation model with a strong influence of the resource and capabilities view of the firm (Barney, 1991; Barney, Wright & Ketchen, 2001; Coriat & Dosi, 2002, Prahalad & Hamel, 1990; Fleury & Fleury, 2001).

At the company, evaluation of training on SCM was based on the participant's perception, but the benefits detected do not emerge from any structured model. Thus, an evaluation approach was configured, considering the benefits suggested by the Association for Operation Management, which includes a relevant set of individual and organizational benefits (APICS, 2015). Nonetheless, it was considered that this evaluation tool could not easily account for the main benefits that the company's decision makers were expecting from SCM training. Indeed, their expectations were associated with the contribution that SCM training could make for the development of the internal resources and capabilities of the company.

Therefore, companies wanted to see measures of the impacts from a particular training program on individual, organizational, and core competencies. In their view, an SCM training program should develop individual competencies, improving the trainee's ability to apply his knowledge, skills, abilities and other characteristics that are required to perform SCM functions, activities and practices (Draganidis & Mentzas, 2006; Jackson & Schuler, 2003). Also, according to the company, an SCM training program should develop organizational competencies or capabilities, which could be seen as "ensembles of skills of individual members of the organization and, at the same time, directly organization-embodied elements of knowledge, routines etc. that represent organizational know how about SCM functions and its ability to perform the coordination, integration and orchestration of the set of required tasks, utilizing organizational resources, for the purpose of achieving business results." (Coriat & Dosi, 2002; Helfat & Peteraf, 2003; LeBortef, 1998; Fleury & Fleury, 2004). Lastly, decision makers of the company were expecting that investments in SCM training would have an impact on the company's core competencies, which are those competencies that the company leverages in order to achieve a competitive advantage, and which in turn are supported by other organizational competencies, such as SCM (Prahalad & Hamel, 1990; Fleury & Fleury, 2004).

It should be noted that organizational capabilities and core competencies are not easy to assess, because they "involve bundles of routines, which are strongly tacit in nature […

and] a collective dimension, [which is] irreducible to the sum of individual skills" (Coriat & Dosi, 2002). However, it can be argued that gains and developments in such competencies could be evaluated, because it is possible to perceive them, even when they are tacit, since they reflect the accumulated knowledge. Thus, such improvement in the SCM knowledge base of the company, arising from training is reflected, mainly, in human resources as gains in individual competencies. Also, the knowledge accumulates and gets embedded in organizational systems, which are seen as "management and organizational routines, procedures, instructions, documentation, […] in processes and products and services production flows, and in the ways of performing certain activities in organizations" (Figueiredo, 2005). Lastly, it can be argued that gains in individual and organizational competencies are expected to be reflected in core competencies (Fleury &Fleury, 2004).

In that context, this paper contributes by proposing an evaluation model for specific program training on SCM. This model was applied in a global chemical company, which allowed capturing its impact on organizational and individual competencies, as well as on the core competencies.

It should be pointed out that research provides a better understanding of the relationship between SCM training and a company's core competencies. The proposed procedure includes applying the Analytic Hierarchy Process (AHP) in the context of a global chemical corporation that was interested in assessing its SCM training program. The interviewed sample contained trained employees and their managers. The research methods adopted in this paper are mathematical modelling and surveying. Section 2 introduces a literature review, mainly with concepts on SCM, and training assessment. Section 3 describes AHP in detail. In Section 4, the SCM program training assessment of a global chemical company is presented, and Section 5 concludes and suggests future research directions.

2. Literature Review

2.1 Supply chain management

SCM has become strategically important to the business process. The literature review covered 22 relevant papers from science-journals categorized into seven topics discussed in this section:

- Supplier Selection
- Collaborative Supply Network
- Distribution Network
- Green Supply Chain
- Purchasing Strategy
- Supply Chain Integration
- Value Chain

Papers focused on Supplier Selection used various criteria to evaluate, including price and delivery performance. Chan and Kumar (2007) presented the Fuzzy and AHP as an analytical approach i.e. the combination of the fuzzy set theory and the AHP for global Supplier Selection which is the same procedure used by Chan et al. (2008). Ertay et al.

(2011) used ELECTRE III to evaluate and classify performance of suppliers. Saen (2007) and Sevkli et al. (2007) performed the evaluation process of Supplier Selection incorporating AHP and Data Envelopment Analysis (DEA). Ha and Krishnan (2008) added the Neural Network in Supplier Selection. The review considered 11 papers dealing with Supplier Selection using AHP or AHP combined with other methods.

The Collaboration between companies of another Supply Chain is known as horizontal collaboration. Naesens, Gelders and Pintelon (2009) provided a comprehensive framework for a horizontal collaborative initiative with resource pooling in inventories using AHP. Lin and Ho (2014) proposed an integration of SCM in the hospital industry of Taiwan. The Distribution Network objective is to allocate a number of points of consumption and supply. Ho and Emrouznejad (2009) proposed to evaluate the performance of warehousing using AHP and Goal Programming. Sharma, Moon and Bae (2008) illustrated a distribution network using AHP based on product characteristics.

The Green Supply Chain is an approach for improving environmental performance of processes including supply base environmental performance management and reverse logistics. Hsu and Hu (2008) focused on the Green Supply Chain for investigating the consistency and priority approaches on processes implementation in the Taiwanese electronic industry. Lu, Wu and Kuo (2007) presented a procedure to evaluate cooperating with green supplies using Fuzzy and AHP. Wang et al. (2012) proposed a model using the same method to analyze the risks of different alternatives and green practice in the fashion Supply Chain.

The Purchasing Strategy is based on business strategy alignment. Drake and Lee (2008) investigated the prioritization of components in the business strategy of a South Korean elevator manufacturer using AHP. The Supply Chain Integration is an advantage through SCM that operates by customer demand. Palma-Mendoza (2014) proposed Supply Chain re-design to support Supply Chain Integration with Supply Chain Operations Reference Model (SCOR) and AHP. The Value Chain provides products and services to customer's needs. Rabelo et al. (2007) presented a framework to integrate SCOR, AHP and discrete-event simulation in services and manufacturing in a case study manufacturing in Southeast Asia. The result was effective and practical support for a senior executive's decisions. The details about the topics and methods of the literature reviewed can be seen in Table1.

Table 1
Topic and method

			Topic							Method						
No.	Authorship	Year	Supplier Selection	Collaborative Supply	Distribution Network	Green Supply Chain	Purchasing Strategy	Supply Chain Integration	Value Chain	AHP	DEA	Discrete-event Simulation	ELECTRE III	Fuzzy Logic	Goal Programming	Neural Network
1	Chan, F.T.S. and Kumar, N.	2007	√							√				√		
2	Chan, F.T.S. et al.	2008	√							√				√		
3	Chan, F.T.S. and Chan, H. K.	2010	√							√						
4	Drake, P.R. and Lee, D.M.	2009					√			√						
5	Erdem, A.S. and Goecen, E.	2012	√							√					√	
6	Ertay, T. et al.	2011	√							√			√	√		
7	Ha, S.H. and Krishnan, R.	2008	√							√	√					√
8	Ho, W. and Emrouznejad, A.	2009			√					√					√	
9	Ho, W. et al.	2011	√							√						
10	Hsu, C.W. and Hu, A.H.	2008				√				√				√		
11	Labib, A.W	2011	√							√						
12	Levary, R.R.	2008	√							√						
13	Lin, R.H. and Ho, P.Y.	2014		√						√						
14	Lu, L.Y.Y et al.	2007				√				√				√		
15	Naesens, K. et al.	2009		√						√						
16	Opasanon, S. and Lertsanti, P.	2013			√					√						
17	Palma, M. and Jaime, A.	2014						√		√						
18	Rabelo, L. et al.	2007							√	√		√				
19	Saen, R.F.	2007	√							√	√					
20	Sevkli, M. et al.	2007	√							√	√					
21	Sharma, M.J. et al.	2008			√					√						
22	Wang, X. et al.	2012				√				√				√		

2.2 Training assessment

Training in SCM could also have a pervasive impact on core competencies. Thus, a comprehensive training assessment model should take into account the benefits related to the improvement of core, organizational and individual competencies. Prahalad and Hamel (1990) defined core competencies as "the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies". These competencies do differentiate the company from its competitors creating a competitive differentiation that enchants clients, and propitiates sustainable advantages.

APICS suggests that SCM training could be evaluated using two sets of benefits as Individual benefits and Organizational benefits (APICS, 2015). The literature review provides a description of the benefits (Table 2).

Table 2
Individual and organizational benefits

Benefits	Description	Author
Individual		
Individual recognition	Recognize the individual by the means of its characteristics, valorizing or praising its attributes, conquers, services or capabilities.	Oxford Dictionaries (2015)
Improve SCM knowledge	The adoption and integration of what people know, how well people communicate what they know and how quickly people learn new things, can give a company a sustainable competitive advantage.	Van Zyl (2003)
Credential recognition	The credential allows certified individuals to demonstrate knowledge in the professional activities of SCM.	Lummus (2007)
Validate of knowledge and abilities	To assess a worker's knowledge and abilities must perceive the status characteristic as relevant to an organizational task. In this way, supply chain managers need broad and deep knowledge and abilities.	Treem (2013), Gammelgaard & Larson (2001)
Organizational		
Common understanding of vocabulary and processes	Common understanding the term for a given concept and that terminology would be consistent in the company.	Lummus (2007)
Use of best practices	Methods that have been found to be effective mean for success in accomplishing goals, and that can be used, or adapted for use	Gilbert (2014), Bulkeley (2006)
Improve company performance	The capability to share explicit and tacit knowledge for the company enables competitive performance.	Schoenherr, Griffith & Chandra (2014)
Proven knowledge and organizational skills	Focus on support an individual be more effective to work and operate better in groups and in organizational.	Khadivar et al. (2007)

There are organizational competencies which are specific competencies by business area such as Design, Marketing, Sales, Production and Logistics. Some of these are core competencies of the organization since they are reasons for the company's survival, while others serve as supporters (Fleury & Fleury, 2001). Individual competencies are the skills and capabilities in every person which reflect both the intrinsic and acquired knowledge and personal characteristics (Fleury & Fleury, 2004).

The CPIM program is internationally recognized in all branches of industry and organized into five modules (APICS, 2015):

- Basics of Supply Chain Management - the basic concepts in managing the complete flow of materials in a supply chain from suppliers to customers are covered in the Basics module. Covers manufacturing, distribution, service, and retail industries.
- Master Planning of Resources - explore and be able to apply the principles of demand management, sales and operations planning, master scheduling, and distribution planning, and to identify conditions that require action. Evaluates knowledge of both supply and demand planning for mid- to long-term independent demand.
- Detailed Scheduling and Planning - acquire a working knowledge of the tools and techniques for planning of inventory, including planning techniques such as MRP, CRP, lean, TOC, and projects.
- Execution and Control of Operations - learn to translate plans into operational activities and define and apply techniques in the operations field. Comparing actual output to plans and taking appropriate corrective actions
- Strategic Management of Resources - move your learning to the next level through the SMR module that includes higher-level thinking or strategic planning and implementation of operations.

3. Method

3.1 Analytical Hierarchy Process

Training in SCM can be assessed using qualitative criteria of various SCM processes. The AHP method application uses hierarchy models (Saaty, 2010a). The AHP application is often divided into two phases of the decision process: the problem structuring and the elicitation of priorities through pairwise comparisons (Ishizaka & Nemery, 2013).

The characteristics of the AHP are the adoption of the well-known fundamental scale proposed by Saaty (2010b) to consult experts about the problem's alternatives and criteria, generating a pairwise comparison matrix $\boldsymbol{A}$, in the sequence, using Linear Algebra concepts, as the eigenvector ($\boldsymbol{w}$), and eigenvalue (λ_{max}), it is possible to get their relative priorities. The AHP priorities are obtained with an application of the Perron-Frobenius theorem as presented in (1) (Saaty, 1977):

$$\boldsymbol{A}\,\boldsymbol{w} = \lambda_{\max}\,\boldsymbol{w} \tag{1}$$

The consistency among the comparisons is an important propriety for $\boldsymbol{A}$. If $\boldsymbol{A}$ has consistent comparisons, then $a_{ij} = w_i/w_j$, for $i, j = 1, 2,\ldots n$, where n is the order of $\boldsymbol{A}$, and this way, $a_{ij} = a_{ik}\ a_{kj}$. Besides that, if $\boldsymbol{A}$ is a consistent matrix, then $\lambda_{\max} = n$. The consistency index, μ, calculated by (2), is a measure of the distance between $\lambda_{\max}$ and n:

$$\mu = (\lambda_{\max} - n)/(n - 1) \tag{2}$$

As pointed out by Saaty (2010a), if μ is lower than 0.10 the Matrix $\boldsymbol{A}$ is consistent. Otherwise, a review on the comparisons may be necessary.

There is also a possibility of using ratings, also known as "absolute measures", in the AHP application, i.e. each alternative is compared with many other alternatives, while ratings compare each alternative with an ideal one (Saaty, 2006). The level of performance corresponding to attributes in linguistic scales varies from "Poor" to "Good". Table 3 presents five degrees of quality for training assessment.

Table 3
Five-level degrees of quality

Level	Degree of quality
1	Poor
2	Between Poor and Fair
3	Fair
4	Between Fair and Good
5	Good

4. Evaluation of SCM training

The research presented in this paper was conducted in a global chemical company. Employees and their managers from chemical plants located in the State of Sao Paulo, Brazil, were surveyed. The researched company has around 1,000 employees (including managers) in Brazil, and is one of the top 10 companies in the chemical and petrochemical branches. The company's core competencies were defined as: Drive Innovation, Collaborate for Achievement, Drive Sustainable Solutions, Act with Entrepreneurial Drive, and Demonstrate Customer Focus.

A training program was implemented one year ago to prepare for APICS CPIM. More than 100 employees have participated in the training program. Frequently asked questions regarding the SCM training gains are: "Does the SCM training program deliver individual benefits?", "Does the training program deliver organizational benefits?", and "Does the training program contribute to the strengthening of the company's core competencies?"

Figure 1 presents the Company's core competencies that are an integral part of learning and development programs.

Core competency	Explanation
Drive innovation	Contribute creative solutions and foster the spirit of innovation
Collaborate for achievement	Seek and act upon value-adding opportunities for collaboration within and across units
Drive sustainable solutions	Decide and act persistently to achieve economic, environmental and societal benefits for the long term
Act with entrepreneurial drive	Take ownership for results, overcome obstacles and drive change
Demonstrate Customer Focus	Act to deliver customer value while achieving profitable business results

Figure 1. Company's core competencies

A main step of the AHP is the decomposition of the problem into a hierarchy, by defining the objectives or task's goals, criteria and alternatives. The goal is "Assess SCM training', and the company's core competencies (Figure 1) are the criteria in the second level. Figure 2 presents the hierarchy model applied in the assessment of SCM training.

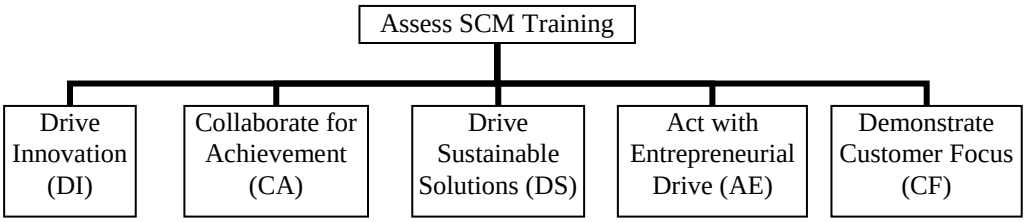

Figure 2. Hierarchy model for training assessment

Data was collected from January to March 2014. 174 company's employees and managers were surveyed by filling out forms evaluating the training benefit according the degree of quality they perceived for each one of the company's core competencies. Those individuals questioned included Supply Chain Managers, Supply Chain Consultant, Supply Planner, Demand Planner, Detailed Scheduler, Master Scheduler, Materials Planner and Customer Service Representative. The profile of the respondents is consistent with our research objectives.

The priorities presented in Table 4 were obtained by normalizing components of $\boldsymbol{w}$. As for "Poor" we have zero priority, this degree was not compared. The consistency index for the comparison matrix presented in Table 4 is around 0.01.

Table 4
Pairwise comparisons of degrees of quality

	G	BFG	F	BPF	Priority
Good (G)	1	2	3	4	1
Between Fair and Good (BFG)	1/2	1	2	3	0.59
Fair (F)	1/3	1/2	1	2	0.34
Between Poor and Fair (BPF)	1/4	1/3	1/2	1	0.20

Table 5 presents the survey's results. For instance, 26 employees or managers judged that SCM training was "Good" for DI.

Table 5
Assessment from employees and managers

Degree of quality (Priority)	DI	CA	DS	AE	CF
Good (1)	26	30	32	44	56
Between Fair and Good (0.59)	81	65	63	73	69
Fair (0.34)	51	56	53	36	41
Between Poor and Fair (0.20)	15	21	22	16	5
Poor (0)	1	2	4	5	3

A priority was computed for a core competency by multiplying the score by the degree of quality divided by total number of employees. For instance, 26 people assessed DI as Good, then $(26 \times 1)/174 = 0.15$; 81 assessed DI as BFG, then $(81 \times 0.59)/174 = 0.27$; 51 assessed DI as F, then $(51 \times 0.34)/174 = 0.10$; 15 assessed DI as BPF, then $(15 \times 0.29)/174 = 0.02$. Summing all these assessments, 0.15, 0.27, 0.10 and 0.02 the aggregate priority for DI is 0.54. The same procedure was performed to CA, DS, AE and CF. Table 6 presents the aggregate priorities from employees and managers assessments.

Table 6
Aggregate priority

Degree of quality	DI	CA	DS	AE	CF
Good	0.15	0.17	0.18	0.25	0.32
Between Fair and Good	0.27	0.22	0.21	0.25	0.23
Fair	0.10	0.11	0.10	0.07	0.08
Between Poor and Fair	0.02	0.02	0.03	0.02	0.01
Poor	0.00	0.00	0.00	0.00	0.00
Aggregate priority	0.54	0.53	0.53	0.59	0.64

The assessment was performed by all employees and managers who attended the SCM training. The aggregate priority (Table 6) for DI criterion was around 0.54, representing the degree of quality Between Fair and Good (Table 4). DI is a core competency to contribute to creative and innovative solutions (Figure 1). For CA and DS the results

were not qualitatively different being around 0.53, which represents the degree of quality Between Fair and Good. CA and DS are core competencies to seek and act upon value-adding opportunities for collaboration. The AE criterion had an aggregated priority equal to 0.59, representing the degree of quality Between Fair and Good. AE is a core competency to take ownership for results and drive changes. The CF criterion obtained the highest priority of 0.64, representing the degree of quality Good. CF is a core competency to contribute to deliver customer value while achieving profitable business results

It was observed in the assessment that employees and managers may have made a significant evaluation and agreed that the SCM training program delivered individual and organizational benefits. It was also clear that the assessment allowed the evaluation of the gains from the SCM training program on the company's core competencies.

5. Conclusions

The main result revealed by this research is that SCM training is really perceived as beneficial, in individual or organizational terms, to a real-world company. Therefore, the company should be confident in the SCM training program to improve and strengthen its core competencies.

The assessment of SCM training and competencies ensures that the company explores the details, and can be used to support the SCM company's strategy mainly linked to Customer Focus and Entrepreneurial Drive. This work reveals that APICS CPIM training enables and prepares employees and managers to make right choices for their organization.

The model presented in Section 4 can be improved by prioritizing core competencies one against another. A long term assessment based on tangible aspects of training effectiveness and efficiency should be considered as one of the next steps in research. Additionally, the proposed assessment presents possibilities for improvement using disaggregate priorities on individual and organizational alternatives as next steps. A new approach based on Benefits, Opportunities, Costs and Risks is suggested as future research.

The model and results of a benefit assessment of training on SCM were primarily developed and obtained in a global chemical corporation. Even though only a plant located in the Brazilian state of Sao Paulo was surveyed, the model and results can be adapted to other locations or industry branches, *mutatis mutandis*.

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