



A New Approach for Performance Evaluation of Supply Chain Management

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Abstract

The management of internal and external processes or functions to satisfy a customer's order from raw materials through conversion and manufacture through shipment is attributed to supply chain management. Recent studies indicate that supply chain performance affects over 85% of a manufacturer's costs and a large percent of its revenues. Monitoring this performance through measurements is practical helping to identify optimization opportunities. Performance measures can be used to monitor the progress of supply chain initiatives. In other words, a performance measure is a value or characteristic to measure output or outcome. In this study, using improved Willis method based on Gunasekaran Model has been presented as a practical method that calculates degree of supply chain management performance. The measurement framework in this study offers guidelines for measuring the supply chain performance in manufacturing units. The case study of this research is relevant to performance measurement of supply chain management in MAHER ANDISH unit considered as one of the largest motor vehicle manufacturers in Iran. Based on Gunasekaran Model, supply chain management levels were divided into 3 levels and 15 criteria. Findings indicate the degree of supply chain management Performance in this industry unit equal to 0.783.

Keywords: Performance measurement, supply chain management, strategy, tactics, operations.

Introduction

In recent years, firms have realized the potential of SCM in the management of day to day operations. However, there are many firms without having enough insight for development of effective performance measures and metrics needed to achieve a fully integrated SCM. This is because they do not have the access to a clear distribution between the metrics at strategic, tactical, and operational levels¹. Measuring supply chain performance can facilitate a better understanding of the supply chain, positively influencing supply chain players' behavior and improving its overall performance². In order to achieve supply chain goal of fulfilling customer orders more quickly and efficiently than other competitors, a supply chain needs continuous improvements³. It is stated that supply chain performance measurement is extremely important in developing supply chain⁴. Therefore, the main question of the research is "What is the degree of supply chain management performance in a certain system?" In this article, using improved Willis method and base on Gunasekaran Model, has been presented practical method that calculates degree of supply chain management performance. In other words, the aim of this study is to create a supply chain measurement framework for manufacturing units, the measurement framework in this study offers guidelines for measuring the supply chain performance in manufacturing units. As a case Study, to demonstrate the application of the proposed method, MAHER ANDISH unit which is one of the largest motor vehicle parts manufacturers in Iran is investigated.

Supply chain management is responsible for the entire lifetime of the product, from preparation of materials and supply management, to production and manufacturing, distribution and customer service, and ultimately recycling and disposal at the end of product life⁵. Recent studies show that supply chain performance affects more than 85 percent of a manufacturer's costs. The new competition is in terms of improved quality, products with higher performance, reduced cost, a wider range of products and better service; all delivered simultaneously⁶.

For any business activity, such as supply chain management, having strategic implications for any company, identifying the required performance measures on most of the criteria is essential and it should be an integral part of any business strategy⁷. The purpose of calculating the performance is to give more information about the degree of achievement of the objectives and is to find actions to improve the values of metrics-consequently total performance⁸. Superior performers are reengineering their supply chains to decrease costs, improve customer satisfaction, and increase profits⁹. Thus, the performance measurement systems are the necessary tools to support decision making¹⁰. Many performance measurement methods have been suggested over the years for SCM evaluation of any organization¹¹. Unfortunately, evaluation methods relying on financial measures are not well suited for newer generation of SCM applications¹². It is an established fact that many companies have not succeeded in maximizing their supply chain's potential, because they have often failed to develop the performance measures needed to fully integrate their supply chain to maximize effectiveness and efficiency¹³. A

study of contemporary manufacturing worldwide practices reported fair uptake and perceived effectiveness of supply chain management¹⁴. While observing these modest levels of uptake and effectiveness, one would expect attention into developing measurement systems and metrics for evaluating SCM performance to be growing¹⁵. Likewise, it has been argued that measuring supply chain performance can result in understanding the supply chain and improving overall companies' performance¹⁶.

Main body

Many companies are adopting the BSC as the foundation for their strategic management system¹⁷. Some managers have used it as they align their businesses to new strategies, moving away from cost reduction and towards growth opportunities based on more customized, value-adding products and services¹⁸. Strategic measurement analysis and reporting technique system consists of a four level pyramid of objectives and measures: corporate vision/strategy, business unit market and financial objectives, business unit operational objectives and priorities, departmental level operational criteria and measures¹⁹. Performance measurement questionnaire involves a workshop to develop, revise, and refocus the set of performance measures²⁰. It has the advantage of providing a mechanism for identifying the improvement areas of the company and their associated performance measures²¹. However, it cannot be considered a comprehensive integrated measurement system and does not consider continuous improvement²². Strategic performance measurement system presented as action-focused tool, which concentrates on the organization's strategies²³. The concepts and ideas were developed by hands-on experience²⁴. Integrated dynamic performance measurement system developed to achieve an integrated system by combining three main areas of the company: management, process improvement team, and factory shop floor²⁵. The need of performance measurement systems at different levels of decision-making, either in the industry or service contexts, is undoubtedly not something new²⁶. Performance measurement describes the feedback or information on activities with respect to meeting customer expectations and strategic objectives²⁷. It reflects the need for improvement in areas with unsatisfactory performance, Thus efficiency and quality can be improved²⁸. In this section, make an attempt to summarize some of the most appropriate methods of systems performance measurement and measurement of SCM²⁹. The balanced scorecard had proposed as a means to evaluate corporate performance from four different perspectives: the financial, the internal business process, the customer, and the learning and growth³⁰. For any firm, the first activity to begin with is to procure orders. It is clear that the way the orders are generated and scheduled determines the performance of the downstream activities and inventory levels. Hence, the first step in assessing performance is to analyze the way the order-related activities are carried out. To do this, the most important issues, such as the order entry method, order lead-time and the path of order traverse, need to be considered³¹. Recently, buyer-supplier partnership has gained a tremendous

amount of attention from industries and researchers, resulting in a steady stream of literature promoting it³². Most of these studies stress the partnership for better supply chain operations. Accordingly, an efficient and effective performance evaluation of buyer and/or suppliers is not just enough; the extent of partnership that exists between them needs to be evaluated and improved, as well. This measurement is aimed to integrate the customer specification in design, set the dimensions of quality and the feedback for the control process. They contain product/service flexibility, customer query time, and post-transaction service³³.

Holistic process performance measurement system presented especially for modern process-based businesses. It assesses the performance of the processes for five aspects: financial view, employee view, customer view, societal view, and innovation view³⁴.

As an important part of SCM, the performance of the production process also needs to be measured, managed, improved, and suitable metrics for it should be established. This category consists of range of product and services, capacity utilization, and effectiveness of scheduling techniques³⁵. These measures are designed to evaluate the performance of delivery and distribution cost in supply chain. The typical measures for delivery performance evaluation are lead-time reduction in the delivery process, on-time delivery (Note 1), distribution mode, the delivery channel, vehicle scheduling, and warehouse location, the percentage of goods in transit, quality of information exchanged during delivery, number of faultless notes invoiced, and flexibility of delivery systems to meet particular customer needs³⁶. Determining the total logistics cost can assess the financial performance of a supply chain. It is necessary to decide on a broad level of strategies and techniques that would contribute to the smooth flow of information and materials in the supply chain environment. They are used to assess the financial performance of supply chain, such as assets cost, return on investment, and total inventory cost³⁷.

The initial Willis method was used in 1990 for choosing some suppliers³⁸. In this method, different features and characteristics of various sizes and significance convert to a single unit³⁹. In Willis method, weighted value of experts is not considered for scoring according to their skill level, it implies that an expert and a novice have same weighted value and effectiveness of weighted value of experts is ignored by using a simple average⁴⁰. So this method improved and a new method has been introduced which weighted value of experts in scoring according to their skill level and experience has been included⁴¹. In Willis improved method, scores given by experts would not be smoothed using a simple average and each score would be considered in calculations individually⁴². Willis improved method has been presented in equation-1:

$$DA_j = \sum_{i=1}^n \frac{W_{ij}}{y} \left(\sum_{k=1}^m (d_k \times X_{ik}) \right) \quad (1)$$

$$\forall_{j=1}^n \sum_{i=1}^n W_{ij} = 1, 0 < W_{ij} < 1$$

$$1 \leq \sum_{k=1}^m X_{ik} \leq 9$$

$$\sum_{k=1}^m d_k = 1, 0 \leq d_k \leq 1$$

Where: DA_j is the degree of adaptability of jth criteria with standard characteristics. n shows the number of criteria which are subsets of a level. W_{ij} is the weight of ith criteria from jth level. X_{ik} is the score given by kth expert to ith criteria. m shows the number of experts. d_k is the kth weighted value of expert. y is the standard score of criteria (y=9). P shows the number of levels.

In Willis improved method, to achieve more accuracy, weighted value of experts is included in scoring. Also, weighted value of experts can change from one level to another. For example, weighted value of expert to judge "A" level criteria was .2, .3, .5 then to judge "B" level criteria, the weighted value of same expert can be .25, .35, .4, respectively. This shows the flexibility of this improved method, because experts may have a high skill level in a special field and a low skill level in another one. If experts have a high skill level in a special field, it is clear that in this case, weighted value of experts will be high and in the other field which they have a low skill level, their weighted value will be low. Also, it should be noted that the number of judging experts can be different from one level to another levels and still the calculation is accurate. For example, if the number of judging experts on "A" level criteria is 3, with a weighted value of .2, .3, .5, then the number of experts to judge on "B" level criteria can be 4 with a weighted value of .2, .3, .4, .1, respectively. This shows the high capability of this formula, too. It is clear that experts may have high skill in a certain field and participate in judging groups while they have not high skill in another field and could not participate in the judging group. For determining the total degree of performance, formula No. 2 is presented as follows:

$$DA_{Total} = (DA_1)^{W1} \times (DA_2)^{W2} \times (DA_3)^{W3} \times (DA_4)^{W4} \quad (2)$$

Based on Gunasekaran model, the metrics or are classified into strategic, tactical and operational levels of management. Gunasekaran states that SCM could be measured in various management or operation levels. The main idea was to assign measures where they can be best dealt with the appropriate management level, thus facilitating quick and appropriate decisions. Strategic level measures influence on the top management decisions reflecting the investigation of board based on policies and level of adherence to organizational goals. The tactical level deals with resource allocation and measuring performance against targets to be met in order to achieve results specified at the strategic level. Operation level measurements and metrics require accurate data and the decision made by low level managers. In operational level, metrics are relevant for day

to day business, thus, the main metrics are time related. Many of these metrics are time-related but also cost-related. These metrics are for top management in order to make strategic decisions as well as long-term plans and strategies. High performance metrics were the target broader functional areas of supply chain configured by Gunasekaran (tables-1 to 3).

Table 1

Evaluation factors of " Strategic Level"
Total cash flow time
Rate of return on investment
Flexibility to meet particular customer needs
Delivery lead time
Total cycle time
Buyer–supplier partnership level
Customer query time

Table 2

Evaluation factors of " Tactical Level"
Extent of co-operation to improve quality
Total transportation cost
Truthfulness of demand predictability/forecasting methods
Product development cycle time

Table 3

Evaluation factors of " Operational Level"
Manufacturing cost
Capacity utilization
Information carrying cost
Inventory carrying cost

These measures are usually corporate level performance measures. It should be noted that tactical level measures performance against targets and also collects feedback from mid-management level. Operational level metrics require data that is relevant to low level management.

The case study of this research has been conducted in MAHER ANDISH unit which is one of the largest motor vehicle parts manufacturers in Iran. Based on Gunasekaran model, for Performance Measurement of Supply Chain Management 3 main levels and 15 criteria were set. The main levels include strategic, tactical and operational and 15 criteria of subsets were configured (tables-1 to 3). Based on Willis improved method, the following is required for performance measurement:

Weight of main levels and criteria. Weighted value of experts.

Criteria scores

In this step, the paired comparisons and scoring are developed to determine weight and also the score of main levels and criteria by all MAHER ANDISH managers and experts. Tables 4 to 6 indicate the weight and scores of main levels criteria. It should be noted that weight of criteria is determined based on

paired comparisons done by MAHER ANDISH experts and managers. To determine the higher or lower priority of criteria, paired comparison has been performed with the scale of respectively 9 to 1/9.

The only required parameter for equation-1 is weighted value of experts and managers in MAHER ANDISH unit for judging criteria which is described in table-7.

In this stage, degree of levels performance has been calculated based on equation-1 and using tables-4 to 7 as follows:

Table 4

Strategic Level criteria	Weight of Criteria	Scores given by Persons 1 to 5					
Total cash flow time	.211	7.25	7.00	8.00	7.75	6.75	
Rate of return on investment	.205	7.50	7.00	7.75	6.50	6.75	
Flexibility to meet particular customer needs	.116	5.50	6.50	6.50	6.75	7.00	
Delivery lead time	.166	7.50	8.25	7.75	7.25	7.50	
Total cycle time	.111	6.50	6.75	8.25	7.50	7.00	
Buyer-supplier partnership level	.092	6.50	6.50	7.00	7.25	7.00	
Customer query time	.099	7.50	8.00	7.00	6.25	6.75	

Table 5

Tactical Level criteria	Weight of criteria	Scores given by persons 1 to 5					
Extent of co-operation to improve quality	.310	8.00	7.75	7.00	6.25	8.00	
Total transportation cost	.386	7.75	6.75	7.00	7.50	7.75	
Truthfulness of demand predictability/ forecasting methods	.194	6.50	5.75	6.50	6.75	8.00	
Product development cycle time	.110	7.25	7.50	6.25	6.75	7.75	

Table 6

Operational Level criteria	Weight of criteria	Scores given by persons 1 to 5					
Manufacturing cost	.379	7.75	6.00	7.50	8.50	6.00	
Capacity utilization	.331	7.25	7.00	7.50	7.25	5.20	
Information carrying cost	.195	6.00	6.75	5.50	7.75	5.75	
Inventory carrying cost	.095	7.75	6.75	6.50	6.25	6.25	

Table 7

Expert/ Manager	weighted value for judging strategic level criteria	weighted value for judging tactical level criteria	weighted value for judging operational level criteria
1	.28	.18	.20
2	.21	.20	.26
3	.16	.27	.19
4	.20	.15	.16
5	.15	.20	.19

DA (Strategic level) = .793, DA (Tactical level) = .799, DA (Operational level) = .756.

Weight of strategic, tactical and operational levels is determined based on paired comparisons done by MAHER ANDISH unit experts and managers. Weights of these levels are respectively. 375, .298, .327.

Also, the total degree of MAHER ANDISH unit supply chain performance has been calculated based on the equation-2 as follows: DA (Total) = .783

In last section, the most important results of this study are presented as conclusions.

Discussion: Recent studies indicate that supply chain performance affects more than 85 percent of a manufacturer's costs and a large percent of its revenues. Monitoring this performance through measurements is, therefore, practical and helps to identify optimization opportunities. The measurement framework in this study offers guidelines for measuring the supply chain performance in manufacturing units. For any firm, the first activity to begin with is to procure orders. It is clear that the way the orders are generated and scheduled determines the performance of the downstream activities and inventory levels. Hence, the first step in assessing performance is to analyze the way the order-related activities are carried out. To do this, the most important issues, such as the order entry method, order lead-time and the path of order traverse, need to be considered. The case study of this research is relevant to performance measurement of supply chain management in MAHER ANDISH unit which is one of the largest motor vehicle parts

manufacturers in Iran. Based on Gunasekaran Model, supply chain management levels were divided into 3 levels and 15 criteria. Findings indicate the degree of supply chain management Performance in this industry unit is equal to 0.783. The need of performance measurement systems at different levels of decision-making, either in the industry or service contexts, is undoubtedly not something new. In recent years, firms have realized the potential of SCM in the management of day to day operations. However, there are many firms without having enough insight for development of effective performance measures and metrics needed to achieve a fully integrated SCM.

Conclusion

The results of proposed method have been developed based on Gunasekaran model and improved Willis method in MAHER ANDISH unit. Indicate the degree of supply chain management performance in this industry unit is equal to 0.783. Performance degree of tactical level is equal to 0.799 and this level has the maximum performance rate among other levels. Operational level has the minimum performance rate among other levels. It is observed that strategic level has highest importance among other SCM levels in MAHER ANDISH unit. So, promotion of mentioned level will lead to increased degree of SCM performance in mentioned industry unit. Result of this research proves efficiency and delicacy of proposed method in performance measurement of supply chain management. Future research works can use this SCM measurement framework and guideline for measuring the SCM performance in all motor vehicle parts industries. Intuitive understanding of SCM levels importance and rate of SCM levels performance in MAHER ANDISH industry unit, chart has been provided (figure-1).

References

1. Bhagwat R. and Sharma M.K., Management of information system in Indian SMEs: An exploratory study, *Int. J. of Enterprise and Network Management*, **1(1)**, 99–125 (2005)
2. Chan F.T.S. and Qi H.J., A fuzzy basis channel-spanning performance measurement method for supply chain management. Proceedings of the Institution of Mechanical Engineers, Part B: *J. of Engineering Manufacture*, **216**, 1155–1167 (2002)
3. Hausmann M., Becker C., Gather U. and Güntürkün O., Functional cerebral asymmetries during the menstrual cycle: A cross sectional and longitudinal analysis, *Neuropsychologia*, **40**, 808-816 (2002)
4. Bower J.L., and Hout T.M., Fast cycle capability for competitive power, *Harvard Business Review*, 110–118 (1988)
5. Chan F.T.S., Performance measurement in a supply chain, *Int. J. of Advanced Manufacturing Technology*, **21**, 534–548 (2003)
6. Dangayach G. and Deshmukh S., Evidence of manufacturing strategies in Indian industry: A survey, *Int. J. of Production Economics*, **83**, 279–298 (2003)
7. Chan F.T.S. and Qi H.J., Feasibility of performance measurement system for supply chain: A process-based approach and measures, *Integrated Manufacturing Systems*, **14(3)**, 179–190 (2003b)
8. Chan F.T.S. and Qi H.J., An innovative performance measurement method for supply chain management, *Supply Chain Management: An Int. J.*, **8(3)**, 209–223 (2003a)
9. Gelders L., Mannaert P. and Maes J., Manufacturing strategy performance indicators and improvement programs, *Int. J. of Production Research*, **32(4)**, 797–805 (1994)
10. Berrah et al, performance measurement systems, **22(3)**, (2007)
11. Christopher M., Logistics and supply chain management, London: *Pitman Publishing*, (1992)
12. Cross K.F. and Lynch R.L., The SMART way to define and sustain success, *National Production Review*, **8(1)**, 23–33 (1989)
13. Gunasekaran A., Patel C., Ronald E. and McGaughey R., A framework for supply chain performance measurement, *Int. J. of Production Economics*, **87(3)**, 333–348 (2004)
14. Clegg et al, (2002)
15. Dangayach G. and Deshmukh S., Evidence of manufacturing strategies in Indian industry: A survey, *Int. J. of Production Economics*, **83**, 279–298 (2003)
16. Chan F.T.S., Qi H.J., Chan H.K., Lau H.C.W, and Ip R.W.L., A conceptual model of performance measurement for supply chains, *Management Decision*, **41(7)**, 635–642 (2003)
17. Dobler D.W. and Burt D.N., Purchasing and Supply Management, New York, NY: *The McGraw-Hill Companies*, (1996)
18. Ellram L.M., A managerial guide for the development and implementation of purchasing partnerships, *Int. J. of Purchasing and Materials Management*, **27(3)**, 2–8 (1991)
19. Fisher L.M., What is the right supply chain for your product?, *Harvard Business Review*, 105–116 (1997)
20. Ghalayinin A. M., Noble J. S. and Crowe T. J., An integrated dynamic performance measurement system for improving manufacturing competitiveness, *Int. J. of Production Economics*, **48**, 207–225 (1997)
21. Graham T. S., Dougherty P. J. and Dudley W. N., The long term strategic impact of purchasing partnerships, *Int. J. of Purchasing and Materials Management*, **30(4)**, 13–18 (1994)

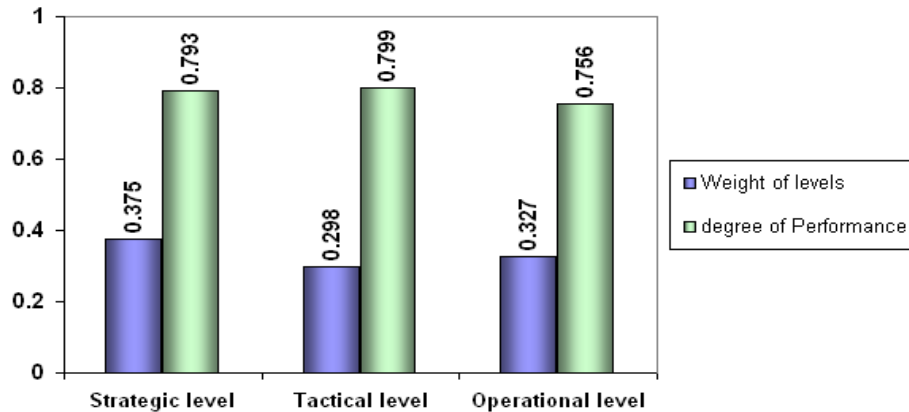


Figure 1
SCM levels based on gunasekaran model

22. Gunasekaran A., Patel C. and Tirtiroglu E., Performance measures and metrics in a supply chain environment, *Int. J. of Production and Operations Management*, **21(1/2)**, 71–87 (2001)
23. Cross K. F. and Lynch R. L., The SMART way to define and sustain success, *National Production Review*, **8(1)**, 23–33(1989)
24. Vitale A, supply chain performance measurement, **10(2)**, 11-18 (1994)
25. Gunasekaran A., Patel C., Ronald E. and McGaughey R., A framework for supply chain performance measurement, *Int. J. of Production Economics*, **87(3)**, 333–348 (2004)
26. Kaplan R. and Norton D., The balanced scorecard: Measures that drive performance, *Harvard Business Review*, **70(1)**, 71–99 (1992)
27. Kueng P., Process performance measurement system: a tool to support process-based organizations, *Total Quality Management*, **11(1)**, 67–85 (2000)
28. Landeros R., Reck R. and Plank R. E., Maintaining buyer–supplier partnerships, *Int. J. of Purchasing and Materials Management*, **31(3)**, 3–11 (1995)
29. Lee H. L. and Billington C., Managing supply chain inventory: Pitfalls and opportunities, *Sloan Management of Review*, *Spring*, 65–73 (1992)
30. Levy D. L., Lean production in an international supply chain, *Sloan Management Review*, *Winter*, 94–102 (1997)
31. Maloni M. J. and Benton W. C., Supply chain partnerships: Opportunities for operations research, *European J. of Operations Research*, **101**, 419–429 (1997)
32. Mapes J., New C. and Szejczewski M., Performance trade-os in manufacturing plants, *Int. J. of Operations and Production Management*, **17(10)**, 1020–1033 (1997)
33. Martinsons M., Davison R. and Tse D., The balanced scorecard: A foundation for the strategic management of information systems, *Decision Support Systems*, **25**, 71–88 (1999)
34. Mason-Jones R. and Towill D. R., Enlightening supplies, *Manufacturing Engineering*, **3**, 156–160 (1997)
35. McBeth D. K. and Ferguson N., Partnership sourcing: An integrated supply chain management approach, London: *Pitman Publishing*, (1994)
36. New S. J., A framework for analyzing supply chain improvement, *Int. J. of Operations and Production Management*, **16(4)**, 19–34 (1996)
37. Novich N., Distribution strategy: Are you thinking small enough?, *Sloan Management of Review* (1990)
38. Mohammad Aghaei, Amin Asadollahi, Reza Salehi Nejad, Mahdi Azar Keyvan, Mostafa Mohammadi Alamoti and Mohammadreza Zare, The Effects of Retailer's Equity on ETKA Customers Shopping Tendency, *Res. J. Recent Sci.*, **3(1)**, 1-6 (2014)
39. Ponce-Hernández M.M., González-Angeles A., Navarro-González C.R. and Cabrera-Cárdeno E., Overall Equipment Effectiveness (OEE) Diagnosis and Improving in a Small Business as an Essential tool for Business Competitiveness, *Res. J. Recent Sci.*, **2(6)**, 58-65 (2013)
40. Houshang Taghizadeh Mehdi Ershadi sis, Supplier's? Selection in Supply Chain with Combined QFD and ANP Approaches (Case study), *Res. J. Recent Sci.*, **2(6)**, 66-77 (2013)
41. Ahmed Riaz, Masood Muhammad Tahir and Azmi Noor, Leadership is Vital for Project Managers to Achieve Project Efficacy, *Res. J. Recent Sci.*, **2(6)**, 99-102 (2013)
42. Houshang Taghizadeh, Saeid Sarbazy Moghadam, Hadi Yasrebdoost and Aziz Razmi, Evaluation of the Relation of Business Ethics and Job Satisfaction, *Res. J. Recent Sci.*, **2(8)**, 56-62 (2013)
43. Ailawadi K.J. and Keller K.L., Retail branding: conceptual insights and research priorities, *Journal of Retailing*, **80(4)**, 331–342 (2004)