

Methodological Proposal to Evaluate and Measure Industrial Logistics Stage

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Abstract

In the global world reality the success of large companies depends on a permanent logistics evaluation. But to measure the stage of logistics level, the methodology, models and references are required. The national and international performance measure in logistics activities references was used. It was carried out to develop a field survey, using a methodology, model and references purposed by this paper. Otherwise, survey results of the use of Information Technology in logistics are analyzed.

Keywords:

Information Technology, Measurement, Logistics Performance

1 INTRODUCTION

Logistics evaluation is a fundamental tool to ensure competitiveness to estimate process and production level, pointing out to the needs of improvement and adjustment. The balance of the supply chain demands performance, adjust and sensibility of logistics reality is essential. The question is, how to evaluate the logistics performance? This paper describes a proposal based on the best practices employed by the main experts in the national and international logistics centers [1].

2 AUTHORS AND CENTERS OF EXCELLENCE SURVEYS

The initial focus of this work considers the classic authors, whose importance of evaluating appears, according to Ballou [2], in the future uncertainties that change the logistics plans performance. The company needs to measure its service levels, for instance, availability index, average time and variability of order cycle time, or it should obtain information on customers' satisfaction according to the patterns of established service level. For that reason, Ballou [2] affirms that the monitoring process needs to have patterns and goals in order to measure its performance (for action reports), to compare and to establish corrective actions. In this sense, Lambert & Stock [3] suggest an evaluation based on meticulous internal and external auditing studies. It comprises a solid guidelines and logistics evaluation. However, because of the large scope, it would be impracticable to use this approach as a pattern for improvement and to use as reference values.

Surveys in the research and service centers of main Brazilian universities have been carried out on the field of logistics performance, screening the most cited center of excellence and authors most referenced. The majority of the work on this field indicates Donald J. Bowersox as the most cited author, and the Council of Logistics Management - CLM, as the international center of excellence, and also Prof. Paulo F. Fleury, as a Brazilian authority on logistics indicators. The Center for Logistics Studies - CEL belongs to COPPEAD-UFRJ (Post Graduate Administration Program of Federal University of Rio de Janeiro), where Prof. Paulo F. Fleury acts as a CEO (Chief Executive Officer). This can be considered as a National Center of Logistics Excellence associated with CLM.

The main work of evaluating the logistics stage was based on a questionnaire elaborated by Bowersox et al. [4], and afterwards re-elaborated by Bowersox [5,6] himself. Among other works, such as Lavalle [7] and Dantas [8], both researchers who carried out surveys on this field, advised by Prof. Paulo F. Fleury, are also considered in great extent.

3 QUESTIONNAIRE

3.1 Questionnaire elaboration

The formulae used by Dantas [8], due to its current contents, was considered to be more adequate to use as standard for the selected questionnaire, specially because it incorporates the out of phase concepts, which enrich the survey with updated perception and knowledge of the interviewed logistics CEOs.

The work carried out by the author consisted of a comparative study of the logistics stage in three companies of the beverage sector, thus, being effectively the case study.

However, the questionnaire extracted from Bowersox et al. [9] is, increase from four basic topics to seven topics, which are:

1. General characteristics (number of staff, market share, etc);
2. Strategy and logistics complexity (products diversity, market support, etc);
3. Formalization (how the logistics organization influences the structure);
4. Performance monitoring (use and importance of indicators of cost, quality, productivity, customer service, asset management and benchmarking);
5. Information Technology (extent of the use of software and hardware);
6. Flexibility (high management capacity to tackle non-routine situations and exploit business opportunities, such as to attend "windows orders");
7. Performance (vision of the company and its position in a competitive environment);

Meanwhile, according to Silva and Menezes [10] the “questionnaire must be objective and limited in extension”. And, in the methodology that is proposed for data collection, whereby the questionnaire must be answered voluntarily by a considerable amount of CEOs representing the population of companies, i.e., for one different methodology of the case study, with the personal interview, as in the case of Dantas, the extension must be effectively limited. The following section indicates the methodology used to adjust these questionnaire models for a descriptive survey, through data gathering.

3.2 Structure of the questionnaire

The authors decided to use the questionnaire that contemplates only four topics proposed by Bowersox et al. [11], but enriched with the concepts of gaps. This allows the contribution of updated perception and knowledge by the logistics CEOs. In short, the questionnaire by Dantas had excluded questions related to topics 1, 2 and 7, described previously.

It should be mentioned that the excluded items, i.e., general characteristics, logistics strategy and complexity, and the performance are the data of greater interest in the case study, which aims at showing the peculiarities of each case considered. In this way, besides adapting to the extension of the questionnaire to its goals, it has kept the original reference model, the *Leading Edge Logistics*, developed by Bowersox. It states that the formalization, together with the intensive use of information technology and performance measurement, generates flexibility.

Formalization

It aims at measuring, according to Bowersox et. al. [11] the degree of organizational formalization, i.e., when it seeks to establish the business strategy by the written rules, plans, objectives and procedures. Furthermore, Bowersox et al. [11] state that as far as the hierarchical presence of logistics CEO in the company, the better will be the logistics performance. It also states that the leading edge companies point out that the planning has increased considerably to comprise the working order and the control sectors.

Performance monitoring

It aims at measuring the degree of importance, attributed to several logistics activities performance indicators, which monitor costs, assets, productivity, customer service, quality and benchmarking, as well as the level of the true fitness.

Information Technology

It seeks to measure the level of actual and planned use, the technology in the supply sector and physical distribution of the company. In this sense, it evaluates: the structure and data processing, the availability of software and hardware, as well as the quality and importance of information systems.

Flexibility

It seeks to evaluate the desired capacity and the true reaction of companies, in case of non-routine situations, such as the demand for non-programmed orders.

3.3 Reference values

The results of Bowersox et al. [12] refer to about 200 leading edge companies in the United States, in their stages of logistics development, and they show reference of excellence.

The methodology applied to a given region allows that the mean values of this region could be compared with those

attained by Bowersox et al. [12], and companies of this region, can also be evaluated individually, with the general performance of the stage of the regional logistics development attained in the data collection.

3.4 Application of questionnaire

The questionnaire was sent to 98 companies selected from the Industrial Data of Paraná – 2001 [13]. The criteria were to be located in CMR (Curitiba’s Metropolitan Region – the capital city of the State of Paraná) employing staff of over 100 people, as an indicator of the size of the company. All these companies were contacted previously by phone to confirm the address printed in the data bank, the name of the main person in charge (senior executive) and also the person responsible for logistics.

The chosen methodology for questionnaire distribution was the same adopted by Bowersox, i.e, this was forwarded by postal mail. For this, printed stationery with logo of PPGTE – Post Graduate Program in Technology of CEFET-PR – Federal Center of Technology Education of Paraná, was used. Inside this stationery, the introduction letter, the questionnaire, and stamped stationery addressed to PPGTE, were enclosed.

The initial explanation of the questionnaire was to enlighten the aims and benefits of the survey.

The aim was to work in partnership with companies, whereby the information will receive confidential treatment, and will help to draw the profile of the logistics stage of the companies in the region, and could possibly help them to identify the own logistics stage that can generate competitive advantages.

In five months of intense monitoring only 28 returned questionnaires were registered. With this amount it was possible to process the data gathered for the analysis.

Below are the answers related to Information Technology, a brief analysis and some conclusions.

4 ANALYSIS ON THE RESULTS ON INFORMATION TECHNOLOGY

As mentioned previously, this paper presents the analysis of survey results carried out in CMR, related only to the use of the information technology.

With regard to measuring the level of actual and planned use of Information Technology in the supply sector and physical distribution of the company, it was evaluated the following: the structure and data processing, the availability of software and hardware, as well as the quality and importance of information systems.

4.1 Hardware availability

The hardware availability in the companies surveyed is presented in Table 1, where the column ‘In use’ represents the resource already in use and ‘Next 2 years’ the resource to be acquired in the next two years.

Table 1 shows that microcomputers are the hardware resources mostly used (91%), being all interconnected in the network. The less used resources are the robots (18%), the automated material handling equipment, computer on-board delivery vehicles and the systems that use voice data capture.

According to Table 2, there is no discrepancy in the hardware used by the logistics in RMC observing the results of the other researches.

Intensive use of computer hardware can be verified, for instance, of microcomputers in more than 90% of the companies in the logistics sector, and more than 80% of them are connected with the network.

Operational	In use	Next 2 years	Total
Bar codes	9%	64%	73%
Optical-scanning devices	18%	46%	64%
Robotics	18%	0%	18%
Automated material handling equipment	0%	18%	18%
Computer on-board delivery vehicles	9%	9%	18%
Computers on-board lift trucks	9%	27%	36%
Automated storage and retrieval systems	9%	18%	27%
Computer			
Mainframe	36%	0%	36%
Minicomputers	27%	9%	36%
Microcomputers	91%	0%	91%
Local area networks	82%	0%	82%
Fiber optics	55%	9%	64%
Hand-held data-entry devices	27%	27%	54%
Voice data capture	18%	0%	18%
CD-ROM	46%	9%	55%

Table 1 - Operational / computer hardware

Operational	RMC 2003	Dantas 2000	Chiarini 1998	Lavalle 1995	Bowers 1989
Bar codes	9.1%	0%	0%	0%	27%
Optical-scanning devices	18.2%	0%	0%	0%	16%
Robotics	18.2%	0%	33%	0%	8%
Automated material handling equipment	0.0%	0%	33%	10%	24%
Computer on-board delivery vehicles	9.1%	0%	0%	0%	16%
Computers on-board lift trucks	9.1%	0%	0%	10%	6%
Automated storage and retrieval systems	9.1%	0%	33%	0%	17%
Computer					
Mainframe	36.4%	100%	33%	70%	4%
Minicomputers	27.3%	0%	0%	20%	8%
Microcomputers	90.9%	100%	100%	90%	83%
Local area networks	81.8%	100%	67%	40%	23%
Fiber optics	54.5%	33%	0%	30%	6%
Hand-held data-entry devices	27.3%	67%	33%	10%	19%
Voice data capture	18.2%	0%	0%	0%	54%
CD-ROM	45.5%	0%	0%	0%	6%

Table 2 - Surveys results with operational / computer hardware (just in use, %)

It is also noticed the use of the operational hardware, although in much more modest scale. However, some of those resources are of specific use and are not justified in many applications. Therefore, in spite of being low, the occurrence of their use already characterizes the existence of local culture in the use of those resources.

4.2 Software availability

Table 3 shows which software is considered, for the interviewees, as the most important for logistics administration.

It has been determined as the most important software referred to the logistics, the purchasing system, sales forecasting and inventory control system. With a lesser importance DRP (Distribution Resources Planning), artificial intelligence systems and shelves management system.

Regarding the software used in logistics systems, Table 4 allows to visualize the interviewees' average satisfaction degree with the respective systems installed in their companies, through the normalized gap, in a scale from zero to five.

The systems considered as the ones that mostly satisfy the logistics are the inventory control and the order processing and warehouse – on-line receiving. The systems that less satisfies are DRP and the artificial intelligence systems.

Satisfaction with systems in use	Average	Order
Purchasing	4.64	1
Sales forecasting	4.54	2
Inventory control	4.54	2
Order entry	4.32	7
Order processing	4.39	5
Warehouse – on-line receiving	4.14	13
Warehouse – order selection	4.04	16
Warehouse - merchandise locator	4.14	13
Warehouse - workload balancing	3.82	20
Warehouse – CAD	4.00	17
Freight / audit and payment	4.31	8
Vehicle routing and scheduling	3.91	19
Inbound freight consolidation	3.74	21
Outbound freight consolidation	4.17	12
Supporting Financials	4.50	4
Performance measurement	4.08	15
Distribution Modeling	4.00	17
Direct product profitability	4.31	8
Direct store delivery	4.23	10
Shelves management	3.74	22
MRP	4.33	6
DRP	3.63	24
Electronic order transmission	4.22	11
Artificial intelligence	3.63	23
Average	4.14	

Table 3 - Importance of logistics orientated systems

These last ones, according to Bowersox [4], were included in the research as emerging IT, "leaving the laboratories directly to the directors' corporations cabinets", framed in the category of specialist systems, aiming at offering, through algorithms and decision rules, an accumulated potential of experience and specialists' knowledge in logistics administration.

Among more than 100 applications of artificial intelligence in logistics now in course, Ballou [14] mentions the software TRACKS used by Santa Fé Railway and MOVING of Digital Equipment Corporation.

Aiming at evaluating systems with greater investment priority, Table 5 exhibits a comparison among the degree of importance of each system in the interviewees' average and the respective satisfaction with the same systems running in their companies according to their own perceptions.

Both comparison terms appear nested in decreasing order of importance and satisfaction. Then, the larger is the negative difference between importance and satisfaction, the larger is the investment priority.

According to this methodology, Sales forecasting system is priority. In fact, it appears as one of the most important and simultaneously shows one of the worst satisfaction degrees.

Table 6 shows that there is no discrepancy in the software used by the logistics in RMC.

Satisfaction with systems in use	Average	Order
Purchasing	40.00	8
Sales forecasting	47.14	17
Inventory control	32.57	1
Order entry	40.00	8
Order processing	35.00	2
Warehouse – on-line receiving	35.27	3
Warehouse – order selection	36.00	4
Warehouse - merchandise locator	48.91	21
Warehouse - workload balancing	46.73	16
Warehouse – CAD	49.33	22
Freight / audit and payment	40.46	11
Vehicle routing and scheduling	40.70	12
Inbound freight consolidation	37.74	5
Outbound freight consolidation	39.65	7
Supporting Financials	42.00	14
Performance measurement	41.00	13
Distribution Modeling	48.00	19
Direct product profitability	47.85	18
Direct store delivery	40.36	10
Shelves management	48.00	19
MRP	38.67	6
DRP	56.00	23
Electronic order transmission	45.39	15
Artificial intelligence	57.68	24
Average	43.10	

Table 4 - Satisfaction with logistics orientated systems

Systems in use	Importance (1)	Satisfaction (2)	Comparison (1) – (2)
Purchasing	1	8	-7
Sales forecasting	2	17	-15
Inventory control	2	1	1
Order entry	7	8	-1
Order processing	5	2	3
Warehouse – on-line receiving	13	3	10
Warehouse – order selection	16	4	12
Warehouse - merchandise locator	13	21	-8
Warehouse - workload balancing	20	16	4
Warehouse – CAD	17	22	-5
Freight / audit and payment	8	11	-3
Vehicle routing and scheduling	19	12	7
Inbound freight consolidation	21	5	16
Outbound freight consolidation	12	7	5
Supporting Financials	4	14	-10
Performance measurement	15	13	2
Distribution Modeling	17	19	-2
Direct product profitability	8	18	-10
Direct store delivery	10	10	0
Shelves management	22	19	3
MRP	6	6	0
DRP	24	23	1
Electronic order transmission	11	15	-4
Artificial intelligence	23	24	-1

Table 5 - Comparison between degree of importance and satisfaction of the systems

Table 6 also illustrates that the average percentage of systems used in RMC (84%) is the largest among the results obtained by other authors in other areas. Besides, it can be verified that the more recent is the survey, larger is the result. Then, it can be concluded that the software use is increasing.

All the systems are used in more than half of the companies considered, and only four, of a total of 24, are used in less than 75% of the companies.

The answers with respect to the use of EDI - Electronic Data Interchange - appear in Table 7.

It can be verified that the use of this resource is intense among the surveyed companies. Also, the forecast for the next 2 years of increased use is significant.

Systems in use	RMC 2003	Dantas 2000	Lavalle 1995	Bowers 1989
Purchasing	100%	67%	100%	72%
Sales forecasting	100%	67%	70%	74%
Inventory control	100%	100%	100%	75%
Order entry	100%	100%	90%	95%
Order processing	100%	100%	90%	94%
Warehouse – on-line receiving	79%	67%	70%	58%
Warehouse – order selection	86%	67%	70%	67%
Warehouse - merchandise locator	79%	67%	40%	57%
Warehouse - workload balancing	79%	67%	40%	30%
Warehouse – CAD	64%	67%	40%	17%
Freight / audit and payment	93%	67%	90%	63%
Vehicle routing and scheduling	82%	100%	80%	32%
Inbound freight consolidation	82%	33%	60%	29%
Outbound freight consolidation	82%	67%	80%	53%
Supporting Financials	93%	67%	90%	78%
Performance measurement	86%	67%	100%	70%
Distribution Modeling	82%	67%	60%	44%
Direct product profitability	93%	100%	90%	45%
Direct store delivery	79%	100%	60%	29%
Shelves management	68%	67%	30%	23%
MRP	75%	67%	40%	54%
DRP	57%	67%	40%	32%
Electronic order transmission	82%	67%	80%	54%
Artificial intelligence	68%	0%	10%	4%
Average	84%	71%	68%	52%

Table 6-Results of the surveys as for the systems returned to the logistics

Table 7 still allows verifying that its use with customer, retailers and financial institutions is a consolidated pattern. EDI with carriers is growing a lot and it is also consolidating. However, the use of co packers/contractors is still very low.

Existence of EDI	Use	Next 2 years	Total
Customers	15	6	21
Retailers	12	7	19
Carriers	7	6	13
Financial institutions	14	2	16
Public warehouses	1	1	2
Co packers/ contractors	6	4	10

Table 7-Level of EDI use

EDI users	RMC 2003	Dantas 2000	Chiarini 1998	Lavalle 1995	Bowers 1989
Customers	54%	0%	20%	67%	28%
Retailers	43%	0%	10%	33%	23%
Carriers	25%	0%	30%	0%	26%
Financial institutions	50%	100%	60%	33%	27%
Public warehouses	4%	0%	10%	0%	21%
Co packers / contractors	21%	0%	0%	0%	6%
Average	33%	17%	22%	22%	22%

Table 8 - Results of level of EDI usage

The relationship with public warehouses is low due to the low inclusion and use of that storage type in Brazil.

Table 8 shows that there is no discrepancy in the use of EDI by the logistics in RMC. Indeed, Table 8 allows verifying that the average percentage of companies, using this system in RMC (33%) is the largest, compared to the results of other authors' surveys in other regions.

The percentage of 33% would be even larger, if it was purged, the percentage of public warehouses.

The fact that almost half of the companies often use this system with customers, retailers and financial institutions, leading to the conclusion that its use is already consolidated.

The last aspect considered in the survey referred to the Information Technology was the level of the interviewees' satisfaction in the computer support sector. The results of this part of the survey are presented in Table 9. Those subjects were the ones that had the lowest evaluations.

Attributes of Quality of the Information	Average
Timeliness of information	4.11
Accuracy of information	4.18
Readily available information	3.85
Information formatted on an exception basis	3.42
Information appropriately formatted to facilitate use	3.82
Average (1)	3.88
Attributes of Quality of the Information	
As the amount of available information in computer	3.93
As for the period for development of systems of information	3.19
As the priority of the systems of information of the logistics regarding the of other sectors of the company	3.69
As the quality of the systems of information of the logistics when compared to the others of other sectors of the company	3.58
Average (2)	3.60
Average (1) and (2)	3.74

Table 9 - Satisfaction level with systems area

The subjects where there is great satisfaction concern the accuracy and the timeliness of the information, with the averages of 4.18 and 4.11 respectively. Furthermore, the subjects evaluated as worse are the period for developing information systems and the Information formatted on an exception basis, with the averages of 3.19 and 3.42, respectively.

5 CONCLUSIONS

This survey aimed at describing one methodology to measure and evaluate the stage of logistics of companies located in the CMR. The methodology described shows conveniently simple, real, propping up in referenced methodology in the application in the case studies, conveniently adapted for a descriptive survey, through the data collection with the use of a concise questionnaire. The suggested values to evaluate the results are also shown.

Besides, the results of this survey will help to identify authors and centers of excellence cited, in order to facilitate the survey and development of new research on the subject of evaluation of logistics performance in industrial companies.

Finally, the survey carried out in CMR showed the validity of the use of model and the convenience of the use of reference standards, allowing the evaluation of the stage of logistics development in this region, particularly on Information Technology.

It also allowed to identify points to be corrected in the logistics organizational culture of companies in the region, such as the need to give priority of investments in software for sales forecasting, regarded as the most important and that simultaneously introduces one of the worst degrees of the users' satisfaction. It indicates the possibility to enlarge the convenience of the use of EDI with co-packers/contractors. Mainly, it points to obtain greater support to the computer tools sector, in order to decrease the period for information systems development and to Information formatted on an exception basis. After all, according to the adopted model, performance monitoring associated with the intensive use of Information Technology and formalized organizational structures, generate flexibility that assures constant attainment of competitive advantage, contributing to the regional development.

6 SUMMARY

This paper summarizes a field survey using a methodology, model and references. It also analyzes survey results on the use of Information Technology in logistics.

7 ACKNOWLEDGMENTS

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