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UKRAINIAN MACHINE-BUILDING ENTERPRISES LOGISTIC SYSTEMS DIAGNOSTICS

Abstract. The present article is devoted to machinery-building companies' logistic systems evaluation. The survey reveals the peculiarities of Ukrainian enterprises development and efficiency based on their life cycle and logistic system state research. This study presents a new approach to company's supply chain management evaluation as a core part of enterprise's life. Authors' methodical background states for strategic, tactical and operational levels of management. The logistic system state (LSS) was studied by three denominations: company's logistic flow at the operational level of management, logistic functions as a tactics efficiency evaluation measurement and return on logistics investments (ROLI) as a criterion of enterprise strategic actions. The conducted survey shows the enterprise's abilities to adapt to external changes at every stage of LSS.

Keywords: enterprise logistic system state (LSS), logistic functions, machinery-building industry, supply chain, diagnostic

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Introduction. Nowadays, the organizational set of tools as a mean of managerial tactics helps achieving company's competitive advantage in a short period of time. Ukrainian companies that are supposed to gain competitiveness in order to launch their product to foreign markets or to protect the position they already have had need to take into consideration the set of organizational and managerial potential of their enterprises. At the same time stage of enterprise life-cycle have to be counted as well. That is why company's managers have to create some new and effective decision-making ideas to answer the needs of market and external factors that are predicted by each development phase.

Literature review and the problem statement

The aim of this research is to evaluate Ukrainian machinery-building companies' state and effectiveness of their management by examining their logistic systems state (LSS).

Due to the mentioned aim the following hypotheses state the background of the survey:

1. There is a dependency between enterprise logistic system state (LSS) and company's life-cycle (H1).

2. Company's logistic system state (LSS) refers to the level of logistic functions development (H2).

3. The LSS development reflects the flexibility of machinery-building enterprise (H3).

Potential of logistics as a science had been studied in a lot of researches and surveys. The different angles had been highlighted. The action plan of company's internal and external flows operation had been scrutinized and suggested by Waters D. [Waters 2002], Christopher, M. [Christopher 2005] and Bowersox D.J.; Close D.J.; Cooper M.B. [Bowersox; Closs; Cooper 2002], who stated the integrated function of company's logistic management, Shapiro, J.F. [Shapiro 2006], who investigated the operational level of implementation the conception of unite flow of a company and tried to create a software to optimize enterprise logistics functions, Manzini R.; Gamberini R. [Manzini; Gamberini 2008], who worked on creating unite distribution system for a company that helped to sort out customers and optimize external logistic flow, Lambert, D.M.; Cooper, M.C.; Pagh, J.D. [Lambert; Cooper; Pagh, 1998] who studied supply chain implementation and research opportunities in this field. Logistics capacity to increase adaptive properties of a company is revealed at Ivanov D., Sokolov B. [Ivanov, Sokolov 2010] research. These works reflect the connection between effectiveness of company's general management and the way of its external and internal flows what might bring if well organized the competitive advantage to the enterprise. So, the different way of organizing company's flows represents the different way of enterprise reaction to external factors and environment.

The research of Ponomarenko, V. S., Yastremskaya, E. N. et al. [Ponomarenko, Yastremskaya 2002] proclaimed the need of different managerial tools due to the different enterprise reaction and due to state of a company's development. This makes the background for the H.1 that there is a dependency between enterprise logistic system state (LSS) and company's life-cycle.

Research results. The authors' assumption is that there are 4 stages of company's LSS that vary on company's external and internal logistic flows state, which is described in Table 1.

Table 1 - Life-cycle model approaches

Level of implementation	Development key-factor	Name and number of stages	Criterion for evaluation
Enterprise	Organizational history – evolution and revolution inside the company	Phases (5): creativity, direction, delegation, coordination and collaboration	Growth rate of the industry, age of organization, size of organization, stage of evolution, stage of revolution
Logistic System state	Company's internal and external logistic flows state	Stages (4): launching, growth, inertia and readjustment	Return on logistics investments

Source: authors' development based on [Greiner 1972]

Due to the mention assumption, let's continue further investigation of LSS. Scientists who were involved in this issue discussion (Otenko V.I., Carley K. M., Ivanov D., Sokolov B.) claimed that company's relation with suppliers and consumers might be evaluated via turnover and interrelations of company's assets, by internal and external logistic flows state and by the set of tools and management style of adaptation that is developed and summed up by authors due to the LSS in table 2.

So, the methodological prerequisites of the following survey give the background to Ukrainian machine-building enterprises evaluation research to estimate the influence and type of logistic system state (LSS) to its productivity, effectiveness and flexibility.

Table 2 - Logistic system state (LSS) model

LSS	company's assets interrelation	enterprise resources distribution			innovations implementation stage and life-cycle stage	internal logistic flow state	external logistic flow state	adaptive management type	strategic adaptation
		supplier s	interrela tion	consum ers					
1.Launching	Non-current assets < current assets	accounts payable turnover	<	recei vabl es turn over	creativity	deficit	deficit	passive → active	gene ral chan ges
2.Growth	Non-current assets > current assets	accounts payable turnover	>	recei vabl es turn over	direction	deficit or surplus	optimum	active → proacti ve	linka ge chan ges
3.Inertia	Non-current assets > current assets	accounts payable turnover	>	recei vabl es turn over	delegation, coordination	surplus	surplus	proac-tive → reactiv e	agen t chan ges
4.Readjust ment	Non-current assets < current assets	accounts payable turnover	<	recei vabl es turn over	collabora tion	deficit	deficit	reac-tive → passive	linka ge chan ges

Source: authors' development on [Otenko 2011; Carley 1997; Ivanov, Sokolov 2010].

In order to prove or argue the presented types of LSS, authors developed the model of its evaluation that is presented in table 3.

Table 3 - Company's logistic system state (LSS) evaluation model

Stage name	Characteristics of research stage	Tools	Primary data	Purpose and action plan	Criterion for evaluation
1	2	3	4	5	6
1.Primary data collection	Forming survey aims and goals	Comparative and trend analysis	Enterprise financial statement and balance sheet	1.1. Industry evaluation and perspectives valuation 1.2. enterprises' management peculiarities 1.3.primary data matrix collaboration	1.2.Company's organizational structure; 1.2. Logistic flow maintenance; 1.3. Logistic system functions and features of organizing

End of **Table 3**

1	2	3	4	5	6
2. Internal and external logistic flows diagnostics	Logistic system tactics and operational level investigation	Qualitative analysis; Quantitative analysis; Functional linkage analysis	Company's business plan; senior and middle managers data; internal managerial data	2.1. Questioner elaboration and interviews conduction 2.2. Results validating procedure 2.3. Data matrix observation 2.4. Correlation analysis	2.1. Level of company's logistic functions development 2.2. Concordance coherence coefficient 2.3. Supply, production and distribution indicators 2.4. Significance indicators of gained data
3.Enterprise logistic system modelling procedure	Company's development scenario correction	Decision-making method	Gained supply, production and distribution indicators	3.1. bottle-neck collaboration 3.2. general stimulators database forming 3.3. destimulators database forming	3.1.general managerial advice 3.2.ROLI; 3.3. Stimulators and destimulators indicators
4.Efficiency evaluation	Company's life-cycle and strategy coherence to its LSS	Comparative analysis	LSS peculiarities; ROLI value; Stimulators and destimulators value	4.1. LSS valuation 4.2. Organizational mechanism of adaptive management formation	4.1. External strategy effectiveness criteria 4.2. Criteria of adaptive management efficiency – company's flexibility

Source: authors' development

Description of 1 stage is concerned about aims and goals of the research. The evaluation of company's logistic system state is suggested to bring up by three managerial dimensions: operational level through logistic flow estimation, tactic level by logistic functions development appreciation and strategic level via logistic strategy efficiency that can be rated as Quinn F.J. suggested.

In the further research we will evaluate the condition of company's logistic system effectiveness on its strategy by modified indicator developed in [Quinn 2013], because the data to its calculation can be taken from official financial documents of enterprises that are available at Statistic Centre according to Ukrainian Information Data Policy. The considered criterion can be measured as percentage from net profit of a company to logistic costs to the specified period of time.

The next **2nd stage** of research is devoted to quantitative evaluation of company's logistic system functions by arranging an interview of its senior and middle management stuff. The study investigates the performance of 6 industrial Ukrainian enterprises for 2.5 years (totally 60 observations). Each observation consists of 3 months period data gained from official and managerial inside

sources, from the 3d quarter of 2012 to the 4th quarter of 2014. All studied enterprises form the potential of second sector of Ukrainian economy and represents machine-building industry. The structure of expert groups is presented at table 4.

Table 4 - Expert groups' structure

Enterprise	Interviewee's departments (%)											
	administrative stuff	distribution	human resource	international markets	logistics	economists	finance	technology	marketing	commercial service	production	R&D
Plant Electrotyajmash	20	24	10	30	16	-	-	-	-	-	-	-
Kharkiv Plant of Electric Equipment	24	20	-	-	-	8	4	44	-	-	-	-
State Scientific and Producing Union Communar	24	-	-	40	-	16	12	8	-	-	-	-
State plant Frunze	8	-	-	-	-	-	20	10	-	12	50	-
State Plant Turboatom	14	-	28	-	-	18	-	20	-	20	-	-
Lozovaya Plant Traktorodetal	-	-	4	-	-	30	-	16	-	30	20	-
FED Corporation LTD	16	-	-	-	-	30	-	-	-	40	4	10

Source: authors' development

This survey is used to evaluate factual state of LSS in marketing, financial, production and managerial enterprises' dimensions. The questioner presented by mentioned spheres is illustrated at table 5.

Table 5 - Questioner for experts

Enterprise logistic system level of evaluation	Functional sphere		Questions
Tactics level of enterprise logistic functions of LS	marketing	1	marketing researches regularity
	production	2	level of production potential usage
	production	3	level of technical and technological innovations
	financial	4	financial and material flows timing
	financial	5	level of equity and borrowed capital ratio
	financial	6	borrowed capital used to innovations
	marketing	7	consumers demand oriented approach implementation
	marketing	8	client-orientation in distribution department
	marketing	9	level of company's products promotion to new markets
	managerial	10	new organizational tools usage in producing process
	managerial	11	modern experience implementation in client support services department
	managerial	12	quality of company's supply chain
	managerial	13	quality of company's inventories usage
	managerial	14	quality of internal material flow organization
	managerial	15	quality of material flow organization in the production process
	marketing	16	quality of distribution department work
	production	17	level of transport department potential usage

Source: authors' development

After holding an interview, the next stage of every quantitative (marketing) research due to Mooi E., and Sarstedt M. [Mooi, Sarstedt 2011] is results' validation. Authors suggest calculate Kendal's concordance rank coefficient and check its validity afterward by the following formula. Due to scientific researches the meaning of this ratio has to be over 0,5 in order to valuate results as meaningful and ones that might have enormous impact to the resulted criterion.

$$\chi^2 = W * m * (n - 1),$$ (1)

X^2 – level of W-meaning validation;

W – level of experts' opinion coherence (Kendal's concordance rank coefficient);

m – quantity of experts;

n – number of researched dimensions.

The level of experts' opinion coherence for each studied enterprise is presented at table 6. The results of the survey are described at Table 6.

The survey was held as a verification of presented and necessary level of company's logistic functions development. The survey reflects bottlenecks in company's management while organizing logistic system of an enterprise.

Table 6 – Level of experts' opinion coherence

Enterprise	W meaning	Criterion χ²	Person criterion (table value)
State Plant Turboatom	0,62	496	36,92
Kharkiv Plant of Electric Equipment	0,67	536	36,92
Plant Electrotyajmash	0,68	544	36,92
State Scientific and Producing Union Communar	0,584	467,5	36,92
State plant Frunze	0,61	488	36,92
Lozovaya Plant Traktorodetal	0,69	552	36,92
FED Corporation LTD	0,66	528	36,92

Source: authors' development

Stage 3 of LSS valuation is presented by correlation procedure where we were searching for positive and negative impact of logistic flow elements indicators to the meaning of ROLI.

According to the conducted research [Voznenko, Roman 2015] the following list of indicators to estimate company's logistic flow was developed.

So, the followed research will develop a model for finding dependences between company's flows indicators and its ROLI.

As we can see after running correlation the total amount of indicators had been shrinked dramatically (table 8) and it helped us to avoid double counting of indexes. So all the indexes that left are unique and characterize only one of enterprise flow stage. The regression analysis followed. Its aim was to discover positive or negative relations between left indicators and criterion. The linear regression analysis stated the equations with + and – before flow indicators. After next iterations and linear regression analysis the following list of indicators depending on positive (+) or negative (-) impact on crucial criterion (ROLI) was formed. During the next procedure of the research criteria had been generalized and grouped by their impact.

According to the gained data there are some criteria that might act as

stimulators for one company and as destimulators for another.

Due to this information the following step was made: from total amount of 174 observed cases there had been investigated 17 cases when indicator expressed itself only in the positive or only in the negative way.

Table 7 - Company's flow indicators

Stages of flow	Logistics operations elements (operating level)		
	Supply	Production	Sales
	1	4	7
Preliminary	Existing and preferred distribution channel rate (X_1)	Technical equipment rate (X_{12})	Rhythm supplies rate (X_{19})
	Market share of supplies (X_2)	Size of raw materials at stock(X_{13})	Quality of order (X_{20})
	Amount of time spent to study information about competitors(X_3)	Share of technologically capacious products(X_{14})	Market share(X_{21})
			Ratio of own market share in comparison with the share of biggest competitor (X_{22})
	2	5	8
Main	Real and planned ratio(X_4)	Capital-labour ratio(X_{15})	Share of stocks in total volume of produced goods (X_{23})
	Planned sales of assortment indicator (X_5)		Real conditions of stockage finished goods in warehouse ratio (X_{24})
	Planned need of resources (X_6)		Share of non-damaged goods in total volume of produced goods(X_{25})
	Rhythmicity supply resources indicator(X_7)		Logistic service level ratio (X_{26})
	Optimum size of the order(X_8)		
	3	6	9
Finishing	Indicator of sustainable stock level (X_9)	Storage of semi-finished stock index (X_{16})	Coefficient of costs for auto and railway transportation (X_{27})
	Amount of time spent for order at the warehouse(X_{10})	Overstocked finished goods warehouse index (X_{17})	Share of fixed goods in total volume of returned goods (X_{28})
	Coefficient of supply security(X_{11})	Time for semi-finished stock transmission($X18$)	Time for delivery (X_{29})

Source: [Voznenko, Roman 2015]

Table 8 - List of stimulators and destimulators of ROLI for enterprises

Enterprise	Logistic flow indicators				Total amount of indicators in the beginning (ΣΣ)
	Stimulators	Σ	Destimulators	Σ	
Plant Electrotyajmash	13, 14, 15, 17, 27, 28	6	4, 6, 22, 23	4	29
Kharkiv Plant of Electric Equipment	15, 16, 19, 21	4	2, 3, 7, 9, 17, 26	6	
State Scientific and Producing Union Communar	4, 5,14, 15, 23, 29	6	9, 16, 21,	3	
State Plant Turboatom	5, 11, 13,15, 18, 23, 25, 29	8	1,14, 16, 17, 20,22, 24, 26	8	
Lozovaya Plant Traktorodetal	2, 3, 7, 12, 14, 16, 17, 18, 19, 20, 28	11	4, 9, 11, 21, 23, 24, 26	7	
FED Corporation LTD	4, 5, 13, 15, 19, 21, 23, 24	8	1, 7, 8, 9, 16, 17, 25, 28	8	
Repeating elements	2(1), 4 (2), 5(3), 7(1), 11(1), 12(1), 13(3), 14(3), 15(5), 16(2), 17(2), 18(2), 19(3), 20(1), 21(2), 23(3), 24(1), 25(1), 27(1), 28(2), 29(2)	43 cases	1(2), 2(1), 3(1), 4(2), 6(1), 7(2), 8(1), 9(4), 11(1), 14(1), 16(3), 17(3), 20(1), 21(2), 22(2), 23(2), 24(2), 25(1), 26(3), 28(1)	36 cases	174
Final list of net indicators	5(3), 12 (1), 13(3), 15(5), 18(2), 19(3)	17 cases	1(2), 3(1), 6(1), 8(1), 9(4), 22(2), 26(3)	17 cases	34
Influence to Crutial Criterion (ROLI)	$X_{i\,st} \rightarrow max$		$X_{i\,dest} \rightarrow min$		

Source: [Voznenko, Roman 2015]

According to the survey there had been discovered six stimulators and seven destimulators depending on their positive or negative impact to the crucial criterion.

These "net" stimulate indicators are planned sales of assortment indicator, technical equipment rate, size of raw materials at stock, capital-labour ratio, time for semi-finished stock transmission, rhythm supplies rate; "net" destimulate indicators are existing and preferred distribution channel rate, amount of time spent to study information about competitors, planned need of resources, optimum size of the order, indicator of sustainable stock level, ratio of own market share in comparison with the share of biggest competitor, logistic service level ratio. Collaboration of company's policy that may increase their meaning would

help enterprise to get rid of bottlenecks and improve company's internal and external flows.

Next stage of suggested model is **phase 4** which is presented by conducting quantitative research in order to group companies by the level of their financial and production cycles' duration that might inure the different LSS as it was suggested above.

Based upon scientific works of Oklander M.A. [Oklander 2003], Brauksa I. [Brauksa 2013], Mooi, E., and Sarstedt, M. [Mooi, Sarstedt 2011] the conducted research of clusters analysis was made. The generalized results can be presented in Matrix (figure 1). The general parameters for the developed model are level of ROLI and duration of Financial and Operation Cycles.
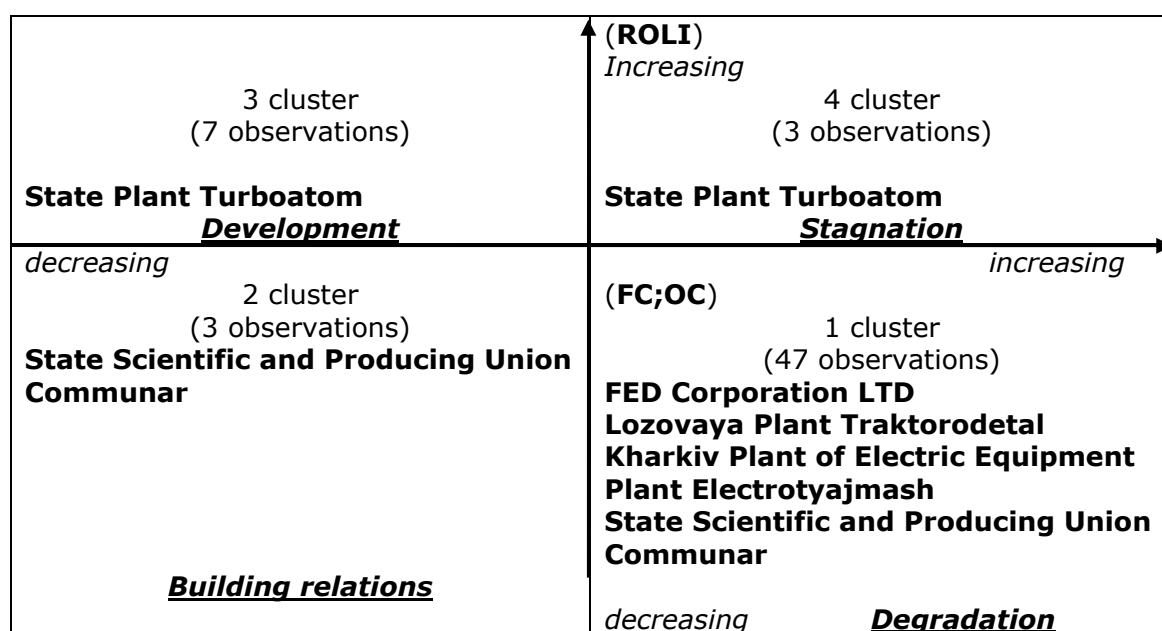
Figure 1 - Ukrainian industrial companies logistic system resulted clusters diagnostics Matrix

Source: [Voznenko, Roman 2015]

To sum up, gained clusters can provide information about the company's market position. The worst cluster from the point of logistic system development and organizing terms and payments with contractors is cluster 1 (Degradation stage). Enterprises from this cluster can evaluate to cluster 2 (Building relations), which can state the better market position in order to optimize the duration of financial cycle and reconsider the terms of payment. The best strategic position on market is for enterprises of cluster 3 (Development), when the company develops steadily and invests in logistics improvement, and at the same moment optimizes its financial and material flow by using sufficient volume of own and borrowed money (sources) for producing renovation. Cluster 4 (Stagnation) can be described as interspaced position; there is a situation when you still profit your investments but had stagnated relations with your consumers. So there are two solutions here: to develop into cluster 3 or have degradation into cluster 1. After evaluating external flows of companies, the next stage of finding interrelations and dependencies between LSS and clusters has to be achieved.

It shows the necessity to design adaptive regulator for its active adaptation to environment and create self-organizing adaptive system upon

collected information about company's behaviour. As previous studies revealed [Andries, Debackere 2006], [Komarunets 2012], [Si-Mohamed 2009] the company's adaptation can be separated by organizational levels as well. So we may define strategic, tactical and operational adaptation as a company's reaction to the environmental changes. So, different reaction as it was suggested at table 2 (passive, reactive, active and proactive adaptations) gives us the permission to make accordance between LSS, matrix clusters and company's life-cycle. The best practice-used set of tools has to take into consideration the peculiarities of company's life-cycle, the field of enterprise activities, relations between suppliers and distributors and the state of its logistic flows. The interrelations between described states of logistic system, matrix clusters and life-cycle are grouped in table 9.

Table 9 - Logistic system state, Matrix and enterprise life-cycle interrelations

LSS	Matrix	Life-cycle
1. Launching	1.Degradation	Creativity
2. Growth	2.Building relations	Direction
3. Inertia	3.Development	Delegation
4. Readjustment	4.Stagnation	Coordination
		Collaboration

Source: authors' development

After making interrelations the next step is to describe got results at the angle of machinery-building industry development.

All enterprises that took part in the described research produce machinery-building widgets for domestic and international markets. The size of studied companies can be defined as big because the total number of employed are more than 100 people for each of them. The organizational structure, general market strategy, peculiarities of organizing and maintaining companies' flows and existence of logistic department had been scrutinized. The results of all 4 stages of machinery-building industry LSS evaluation are presented in table 10.

Table 10 – Ukrainian machinery-building enterprises survey in 2012-2014

Industry	Stage of industry development	Enterprise	Life-cycle stage	Logistic system state (LSS)
Machinery building	Mature, medium capital intensive, high environmental circumstances changes, low technical advance	FED Corporation LTD	Coordination	4.Readjustment
		Lozovaya Plant Traktorodetal	Collaboration	4.Readjustment
		Kharkiv Plant of Electric Equipment	Collaboration	4. Readjustment
		Plant Electrotyajmash	Collaboration	4. Readjustment
		State Scientific and Producing Union Communar	Coordination	4. Readjustment
		State Plant Turboatom	Delegation	3. Inertia

Source: authors' development

The companies' performances evaluation gave the following results. The enterprise (State Plant Turboatom) that implements competitive strategy and is on delegation phase of life-cycle has as cost-function the maximizing decision accuracy and might as adaptation use agent change, LSS phase Inertia gives the possibility to company's development via cooperation to change reactive adaptation to proactive. The representatives of group of coexistence market strategy (FED Corporation LTD and State Scientific and Producing Union Communar) are on coordination phase; they have to maximize as an aim the number of produced widgets and might as adaptation solution implement linkage change. Their LSS highlights the Readjustment phase that might be described as reactive adaptation changes for passive. And the members of cooperation market strategy (Plant Electrotyajmash, Kharkiv Plant of Electric Equipment and Lozovaya Plant Traktorodetal) implementation union are on collaboration phase.

Conclusions. Suggested survey revealed that there is a partially dependence between enterprise logistic system state (LSS) and company's life-cycle, (H1), because for each life-cycle stage could be found the proper LSS, but at the same moment for each LSS there is more than one choice of life-cycle stage. The (H2) had been proved completely because conducted research of Ukrainian companies showed common bottlenecks for the companies with the same level of logistic functions development, so company's logistic system state (LSS) refers to the level of logistic functions development. The presented Matrix movement from one gap to another and set of decision-making tools for each of it proves fully that LSS development reflects the flexibility of machinery-building enterprise.(H3)

The presented research gives the opportunity to build organizational mechanism on the background of different logistic system state and company's life-cycle stage in order to increase Ukrainian machinery-building companies' proactive adaptation and develop this industry's efficiency on domestic and international markets.

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