THE IMPACT OF GLN ON DISTRIBUTION EFFICIENCY – RESULT ANALYSIS OF THE TEST IMPLEMENTATION

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Abstract

The efficiency of distribution processes is determined, among other factors, through timeliness, speed and error-free performance. All these measures indicate both the operational efficiency of distribution processes and the efficiency of information flow between partners in the supply chain. In both cases, the GLN standard, aligned with GS1 standards, can help, which in addition to being able to optimise the monitoring of process realisation and information flow, also optimises the distribution processes themselves. The paper focuses on presenting the basic assumptions of the application of the GLN register to optimise logistics processes. These conceptual analyses were supported by business practice research in the aspect of assessing the efficiency of the application of the GLN standard in distribution processes carried out by a logistics operator.

The research carried out in this area is the result of cooperation between Lukasiewicz Research Network - Institute of Logistics and Warehousing and Poznan School of Logistics, from 2017 to 2021. During the extensive cooperation, activities were carried out both in the conceptual aspect, research, observation of business practice, as well as implementation, aimed at verifying the benefits of the use of GLN standard.

Key words: distribution efficiency, GS1 standards, information flow in supply chain

1. INTRODUCTION

The efficiency of distribution processes depends not only on the economic and organizational aspects of their implementation, but also on the effective flow of information, which is becoming an increasingly important element of competitive advantage in the market (Nakatani et al., 2006; Sliwczynski et al., 2012). Information flow concerns both information integration between counterparties, but also its direct impact on the operational and economic activities of the company. Errors related to inadequate information in logistics processes are, in effect, associated with untimely or incomplete deliveries, the need to make returns, or queues associated with the unloading of goods at the customer's warehouse. Each of these situations is unfavourable from the point of view of efficiency of distribution processes and elimination or attempt to minimize their effects is one of the key optimization activities in business practice.

The GS1 standards allows not only to organize the information processes of logistics in enterprises, but also to improve the efficiency of the processes in a special way, by minimizing the negative effects of operational activities related to erroneous information. One effective solution to this problem is the possibility of using a location register based on GLN identifiers (Dujak et al, 2017; Cudzilo et al., 2018).

The GLN (Global Location Number) is a globally unique number that provides an identification key (per GS1 standards) used to identify any location (physical, digital, functional or legal). The GLN is a 13-digit code consisting of the GS1 company prefix, a location-specific reference, and a check digit. A GLN assigned to legal entities and functions uniquely identifies those entities, while one assigned to physical and digital locations answers the question of where a location is located and what its operating conditions are. The latter meaning is particularly important from the perspective of increasing the efficiency of distribution and warehouse delivery service processes (Korzeniowski, 2018; Kizyn, 2011). Marking and unambiguous identification of locations in the processes carried out in supply chains can be considered as one of the key activities, conditioning the efficiency of these processes (Niemczyk, 2016). This context of the application of GLNs, compliant with the global GS1 standard, is the main element of the analysis conducted by the Authors within this article.

Taking into account the above considerations, both theoretical and practical, the Authors concluded that it is expedient to conduct an analysis of the impact of the application of GLN identifiers on the efficiency of distribution processes.

2. POSSIBILITIES OF USING GLN FOR IDENTIFICATION OF PHYSICAL LOCATION PARAMETRES

The analysed case studies and conducted research indicated the need to develop solutions that allow global (for all entities in supply chains) access to data on locations between which transports are carried out in supply chains. The authors pointed out in this context the possibility of using GLN identifiers to describe the physical attributes of locations, and thus support the processes of distribution and warehouse handling of

supplies. The use of GLN identifiers for tagging physical locations involves defining a range of information that characterizes the location (or facility) and its operating conditions.

As part of the research work conducted by the Łukasiewicz Research Network - Institute of Logistics and Warehousing and the School of Logistics, a proposal of attributes (data fields) that should describe a location or an object within the designed location register was defined (Fig. 1). As can be seen in Figure 1, the basic information that characterizes a location or object, assigned to a unique GLN identifier, in addition to the name and address of the location, is data that allows geocoding, namely the longitude and latitude. However, in order for the description of a given facility to be used to improve the efficiency of distribution processes, parameters such as, among others, the time conditions of facility operation or the means of road transport served should also be specified. All the mentioned information should be identified under the GLN number, according to a specific standard of data collection (strictly defined layout) and using dictionary data for defining specific types of information, within particular attributes

Figure 1. Proposal of attributes describing the physical parameters of a location / facility

PARAMETERS	Value
GLN	5901234123459
Facility name	Centrum Logistyczne
Address	ul. Magazynowa 145
Latitude and longitude	52.406374, 16.925168
Categories of materials stored	(eg. Food, chemicals etc)
Accepted logistic units	(eg. Pallets, containers, roles etc)
Ability to accept the goods with temp. control	(eg. frozen or fresh goods)
Storage temperature	
The possibility of storing ADR materials	(eg. gas, explosive substances etc.)
Supported transport	(eg. TIR, tanker, tilt, cold etc.)
The landing surface	
Types of ramps	(eg. a simple, gear, stepped etc.)
Equipment of the ramps	(eg. crane, lift, loading bridges ...)
Technical conditions of the ramps	(eg. turning radius, maximum load, height ...)
Technical delivery conditions	(eg. pallets arr. by narrow side, stackable acceptable...)

Address and geolocation

Physical attributes of localization, defined using dictionary data

Source: own study

3. ANALYSIS OF THE POSSIBILITY OF INCREASING THE EFFICIENCY OF DISTRIBUTION PROCESS THROUGH PILOT IMPLEMENTATION OF GLN

The analysis of the efficiency of distribution processes is a complex issue. Taking into account the necessity of linking the efficiency with the characteristics of the present project, it is necessary to consider both the economic and operational aspects, but also the aspect of information flow. Developing a set of indicators for assessing the impact of the use of GLN identifiers must therefore illustrate both the cost and operational situation of the analyzed process, but also present the differences

in the flow of information, which indirectly affects the efficiency of distribution processes.

The pilot implementation was conducted in order to present the effects of using the location register based on GLN identifiers. The following tables present a summary of the indicators that were finally monitored and analyzed on the processes implemented by the logistics operator.

Table 1. Proposal of indicators for assessing the impact of implementation on the efficiency of transport processes in economic and operational approach

Lp.	Meter name	Template	Characteristics	J.m.
1.	On-time delivery rate	$\frac{a}{b}$	a – number of on-time deliveries	%
			b – total number of deliveries	
2.	Delivery responsiveness		a – number of orders delivered ahead of schedule	%
			b – total number of orders	
3.	Share of incomplete deliveries to the customer		a – number of incomplete deliveries	%
			b- total number of deliveries	

Source: own research

Table 2. Proposal of indicators to evaluate the impact of implementation on the efficiency of transport processes in information flow approach

Lp.	Mater name	Template	Characteristics	J.m.
1.	Reliability of information flow	$\frac{a}{b}$	a – number of correctly planned deliveries/routs	%
			b – total number of planned deliveries/routes	
2.	Rate of delivery returns due to erroneous data		a – value/cost of returns	%
			b – value/costs of execution of all orders	
3.	Average time to analyze delivery plan data		a – total time of data retrieval	h
			b – number of developed plans	

Source: own research

Following the logic of the implementation efficiency analysis, the data obtained were:

- the situation before implementation (calculated as an average value over a period of half a year before GLN implementation),
- the situation in particular days (test days) of the first week after the implementation (scenario 1),
- the situation in particular days (test days) of the second week after the implementation (scenario 2),

- the situation in particular days (test days) of the third week after implementation (scenario 3).

Data acquisition in terms of test days in each analysed week (scenario) allows the observation of changes in the results of efficiency indicators at different stages after GLN implementation. This approach aims to eliminate the mistake of measuring results caused by the disorganisation of the process after the implementation of a new solution from the perspective of the company's business operations. This approach has not been used in the analysis of the situation before implementation (Table 3) due to the fact that these data have been calculated as an average value over the whole period under analysis (half a year).

Operational data, necessary for the analysis of the implementation efficiency, describing the situation before the implementation is presented in Table 3.

Table 3. Data before GLN implementation

Specifics of the data	Value
Number of on-time deliveries,	168
Number of incomplete deliveries,	5
Total number of deliveries,	177
Number of orders delivered ahead of schedule,	1
Total number of orders,	125
Number of correctly scheduled deliveries/tracks,	6
Total number of planned deliveries/routes,	9
Value/cost of returns [PLN]	274
Value/cost of processing all orders [PLN]	1615
Total download time [min]	55
Number of developed plans	7

Source: Own study

The data presented in the table above and throughout the analysis are for a daily snapshot. The results of the indicators presented in Tables 1 and 2, for data before implementation (Table 3), are presented in Tables 15 and 16, which summarise the whole analysis.

The first stage of the analysis is to evaluate possible changes in parameters and indicators obtained from the scenario concerning the first week after implementation. The data obtained in each variant for the month of July, is presented in Table 4.

Table 4. Operating Data - Week 1

Lp	Specifics data	Test Day 1	Test Day 2	Test Day 3	Test Day 4
1	Number of on-time deliveries,	173	174	176	176
2	Number of incomplete deliveries,	2	3	3	4
3	Total number of deliveries,	176	178	179	181

4	Number of orders delivered ahead of schedule,	1	2	2	3
6	Total number of orders,	125	130	132	135
7	Number of correctly scheduled deliveries/routes,	5	6	6	7
10	Total number of scheduled deliveries/routes,	9	9	9	9
11	Value/cost of returns,	269	232	217	200
12	Value/cost of fulfilling all orders,	1615	1650	1670	1710
13	Total download time,	54	56	54	53
14	Number of plans developed,	7	7	7	7

Source: Own study

The tables below present the obtained results in aggregate, while determining the average value for individual indicators and the weighted average value.

Table 5. Summary of analysis results (economic and operational approach) - week 1

Indicator	Test Day 1	Test Day 2	Test Day 3	Test Day 4	Arithmetic average	Weighted average
On-time delivery rate	98,30%	97,75%	98,32%	97,24%	97,90%	97,77%
Delivery responsiveness	0,80%	1,54%	1,52%	2,22%	1,52%	1,73%
Share of incomplete deliveries to the customer	1,14%	1,69%	1,68%	2,21%	1,68%	1,84%

Source: Own study

The results for on-time delivery obtained from the individual variants do not show any trend during the period studied. This situation may be caused by the speed of implementation, process disorganization and the initial phase of getting familiar with the new solution.

The results for delivery responsiveness, on the other hand, show an upward trend, however between Test Day 2 and Test Day 3 there was a stagnation of the result, nevertheless too small number of analysed variants does not allow to draw constructive conclusions.

The analysis of incomplete deliveries to the customer highlights the increase in the value of this indicator in individual, consecutive variants. It is a negative effect, nevertheless such a good result obtained on the first day of implementation may not be a result of implemented changes. Therefore, further analysis of this indicator should be carried out.

Table 6. Summary of analysis results (information flow approach) - week 1

Indicator	Test Day 1	Test Day 2	Test Day 3	Test Day 4	Arithmetic average	Weighted average
Reliability of information flow	55,56%	66,67%	66,67%	77,78%	66,67%	70,00%
Rate of delivery returns due to erroneous data	16,66%	14,06%	12,99%	11,70%	13,85%	13,05%
Average time to analyze delivery plan data	7,71	8,00	7,71	7,57	7,75	7,71

Source: Own study

In the case of reliability of information flow indicator, the values of individual test days create in an upward trend. The changes are significant, which can testify to the positive impact of the implementation on this analytical range.

The analysis of second indicator generates a downward trend, in proportion between the different options.

The obtained results for last indicator generate a decreasing trend, which should be considered as a positive result. Such a good result obtained in Variant 1 may be due to other factors than the impact of the pilot implementation.

Therefore, the options monitored at a later time have a greater impact on the final outcome of the analysis. Also for the second case study the following weights were adopted:

- Test Day 4 - weight 4,
- Test Day 3 - weight 3,
- Test Day 2 - weight 2,
- Test Day 1 - weight 1.

The second stage of the analysis is the evaluation of possible changes in the same parameters and indicators obtained from the scenario concerning the second week after implementation. The data obtained in individual variants during this period, are presented in Table 7.

Table 7. Operating Data - Week 2

Lp	Data specifics	Test Day 1	Test Day 2	Test Day 3	Test Day 4
1	number of on-time deliveries,	164	168	170	172
2	number of incomplete deliveries,	2	3	2	2
3	total number of deliveries,	166	171	173	176
4	number of orders delivered ahead of schedule,	1	2	2	3
6	total number of orders,	124	125	125	126

7	number of correctly scheduled deliveries/tracks,,	5	6	6	7
10	total number of scheduled deliveries/routes,	8	9	9	9
11	value/cost of returns,	198	195	191	188
12	value/cost of fulfilling all orders,	1650	1625	1620	1610
13	total download time,	52	50	48	46
14	number of plans developed,	7	7	7	7

Source: Own study

The following tables present the results obtained in aggregate, while determining the average value for individual indicators and the weighted average value.

Table 8. Summary of analysis results (economic and operational approach) - week 2

Indicator	Test Day 1	Test Day 2	Test Day 3	Test Day 4	Arithmetic average	Weighted average
On-time delivery rate	97,59%	98,25 %	98,27 %	98,86 %	98,24%	98,43%
Delivery responsiveness	0,81%	1,60%	1,60%	2,38%	1,60%	1,83%
Share of incomplete deliveries to the customer	1,20%	1,75%	1,16%	1,14%	1,31%	1,27%

Source: Own study

The results obtained from individual test days for on-time delivery rate show an upward trend, which should be evaluated as a positive influence of the implemented changes on the timeliness of deliveries. Therefore, it can be cautiously concluded that the introduced implementation positively influenced the value of this indicator.

The analysis of this period indicates a stabilized increase in the value of delivery responsiveness. It is analogous to the previous period and crystallizes a positive trend of changes.

The analysis of third indicator requires the conclusion that the trend is relatively stable, which may indicate that this indicator is approaching the optimal level under the prevailing market conditions. The increase of incomplete number of deliveries in test day 2 should be analyzed against all other analyzed test days.

Table 9. Summary of analysis results (information flow approach) - week 2

Indicator	Test Day 1	Test Day 2	Test Day 3	Test Day 4	Arithmetic average	Weighted average
Reliability of information flow	62,50%	66,67%	66,67%	77,78%	68,40%	70,69%
Rate of delivery returns due to erroneous data	12,00%	12,00%	11,79%	11,68%	11,87%	11,81%
Average time to analyze delivery plan data	7,43	7,14	6,86	6,57	7,00	6,86

Source: Own study

The analysis of reliability of information flow indicates a stabilized increase in the value of this indicator. It is analogous to the previous period and crystallizes a positive trend of change. In the present situation, a slight decrease in the value of the second indicator should be noted, which should still be considered as a positive impact of the new situation on the performance indicators. The obtained results for last indicator generate a downward trend, however, compared to the previous period, the decrease is clear and stable.

The third step of the analysis is to evaluate possible changes in the same parameters and indicators obtained from the scenario for the third week after implementation. The data obtained in the different variants during this period, are presented in Table 10.

Table 10. Operating Data - Week 3

Lp	Specifics of the data	Test Day 1	Test Day 2	Test Day 3	Test Day 4
1	number of on-time deliveries,	175	177	179	181
2	number of incomplete deliveries,	3	2	2	2
3	total number of deliveries,	177	180	185	182
4	number of orders delivered ahead of schedule,	2	3	3	4
6	total number of orders,	119	122	123	120
7	number of correctly scheduled deliveries/tracks,	6	6	7	7
10	total number of scheduled deliveries/routes,	9	9	9	9
11	value/cost of returns,	188	194	186	184
12	value/cost of fulfilling all orders,	1615	1624	1610	1605
13	total download time,	46	44	42	42
14	number of plans developed	7	7	7	7

Source: Own study

The following tables present the results obtained in aggregate, while determining the average value for individual indicators and the weighted average value.

Table 11. Summary of analysis results (economic and operational approach) - week 3

Indicator	Test Day 1	Test Day 2	Test Day 3	Test Day 4	Arithmetic average	Weighted average
On-time delivery rate	98,87%	98,33%	96,76%	99,45%	98,35%	98,36%
Delivery responsiveness	1,68%	2,46%	2,44%	3,33%	2,48%	2,72%
Share of incomplete deliveries to the customer	1,69%	1,11%	1,08%	1,10%	1,25%	1,16%

Source: Own study

The results obtained for on-time delivery rate from the individual test days do not show a trend, nevertheless the average value of the analysed period allows one to state an increase in timeliness of deliveries, compared to the previous periods. The analysis of delivery responsiveness indicates a continuous increase in the value of this indicator. The tendency of changes in the value of the index indicates that it is possible to further optimize this range. The analysis of third indicator confirms the trend of positive change in value. It should be noted stabilization of the index value, which may suggest obtaining a level close to optimal.

Table 12. Summary of analysis results (information flow approach) - week 3

Indicator	Test Day 1	Test Day 2	Test Day 3	Test Day 4	Arithmetic average	Weighted average
Reliability of information flow	66,67%	66,67%	77,78%	77,78%	72,22%	74,44%
Rate of delivery returns due to erroneous data	11,64%	11,95%	11,55%	11,46%	11,65%	11,60%
Average time to analyse delivery plan data	6,57	6,29	6,00	6,00	6,21	6,11

Source: Own study

The value of first indicator showed a jump of more than 10%. This is due to the improvement of data acquisition for the development of plans. This is evidence of the very positive effect of implementing the location register. In the present situation, a slight downward trend in the value of the second indicator should be noted. Despite the small jump in variant two (by 0.5%), the downward trend continues, although it should be noted that the deviations are getting smaller and smaller, which may indicate

that its value has reached the optimal level. The results for third indicator still generate a decreasing trend, which means that the positive impact of implementing a location registry can still be optimized

The next step in the implementation efficiency analysis is to compare the results obtained from each analyzed week after implementation. Both arithmetic and weighted average values were taken for further analysis.

First, the arithmetic averages of the results obtained on each test day were determined. In the second analysis, the same results obtained on each test day were calculated as a weighted average, on the assumption that measurements taken at a longer time after implementation more accurately reflect the facts after GLN implementation. The following tables present comparison the arithmetic values and weighted averages obtained in all test days and all scenarios (weeks) analyzed.

Table 13. Summary of scenario analysis (economic and operational approach)

Scenarios	Week 1		Week 2		Week 3		After implementation general	
Indicator	A (A)	A (W)	A (A)	A (W)	A (A)	A (W)	A (A)	A (W)
On-time delivery rate	97,90 %	97,77 %	98,24 %	98,43 %	98,35 %	98,36 %	98,17 %	98,29 %
Delivery responsiveness	1,52%	1,73%	1,60%	1,83%	2,48%	2,72%	1,86%	2,26%
Share of incomplete deliveries to the customer	1,68%	1,84%	1,31%	1,27%	1,25%	1,16%	1,41%	1,31%

Legend:
A(A) – arithmetic average, A(W) – weighted average
Source: Own study

A comparison of the arithmetic and weighted averages for each scenario od on-time delifery, indicates an improvement in the index value of 10% on average. This is a meaningful effect of implementing a location registry in the surveyed company. When analysing second indicator, the increase is less significant; nevertheless, it should still be considered satisfactory evidence of increased effects after implementation. The value of third indicator should be regarded as a good result, which also demonstrates the efficiency of the GLN implementation.

Table 14. Summary of scenario analysis (information flow approach)

Scenarios	Week 1		Week 2		Week 3		After implementation general	
Indicator	A (A)	A (W)	A (A)	A (W)	A (A)	A (W)	A (A)	A (W)
Reliability of information flow	66,67 %	70,00 %	68,40 %	70,69 %	72,22 %	74,44 %	69,10 %	72,45 %
Rate of delivery returns due to erroneous data	13,85 %	13,05 %	11,87 %	11,81 %	11,65 %	11,60 %	12,46 %	11,91 %
Average time to analyze delivery plan data	7,75	7,71	7,00	6,86	6,21	6,11	6,99	6,63

Legend:
A(A) – arithmetic average, A(W) – weighted average
Source: Own study

When analyzing first indicator, the increase should be considered significant. The results obtained testify to the further possibility of optimizing the flow of information by means of the location register. When analyzing second indicator, the decrease is less significant; however, it should still be considered satisfactory evidence of increased post-implementation effects. In the analysis of last indicator, the result generated the least spectacular end result. Nevertheless, it still confirms the benefits of implementing a location registry in the company studied.

The final step in analyzing the efficiency of GLN implementation is to compare the arithmetic and weighted average values from each scenario (week) to the indicators determined from the data before implementation. Detailed analyses of the results are shown in the following tables.

Table 15. Analysis of implementation efficiency in economic and organizational approach

	Before implementation	After impementation	After impementation (weighted average)
On-time delivery rate	94,92%	98,17%	98,29%
Delivery responsiveness	0,80%	1,86%	2,26%
Share of incomplete deliveries to the customer	2,82%	1,41%	1,31%

Source: Own study

Table 16. Analysis of implementation efficiency in information flow approach

	Before implementation	After impementation	After impementation (weighted average)
Reliability of information flow	66,67%	69,10%	72,45%
Rate of delivery returns due to erroneous data	16,97%	12,46%	11,91%
Average time to analyze delivery plan data	7,86	6,99	6,63

Source: Own study

4. CONCLUSION AND FURTHER RESEARCH

The analysis of the pilot implementation, described in this paper, confirms the possibility of increasing the efficiency of distribution processes by using a location register based on GLN identifiers. The conclusions show the need for further development of the location register prototype.

The authors, indicate that further implementations of the location registry in business practice are warranted. The aim of the implementation was to confirm the possibility of increasing the efficiency of distribution processes through the use of GLN identifiers, describing the physical parameters of the location.

The efficiency analysis carried out in the analyzed company proved the positive influence of the implementation of the location register on the efficiency of logistic processes in the company. The results have been mixed, however the trend of positive impact of the implementation of the location register on each of the mentioned indicators is visible. Further process optimization is possible for this company. This is due to the fast pace of implementation of this solution, and therefore some organizational problems. However, it has to be said that the analysis performed in this form and to this extent can allow to conclude on the benefits of implementing a location register in business practice.

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