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IMPLEMENTATION OF FORECASTING TOOL IN THE LOGISTICS COMPANY – CASE STUDY

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Purpose: The main aim of following article is the implementation and results analysis of created forecasting tool. Created tool is a tool for automated prediction of future demands level in chosen distribution networks where logistics operator is acting as a service provider.
Design/methodology/approach: Article shows the conception of created forecasting tool and presents the deviations of forecasts from real values.
Findings: Logistics enterprise could implement the forecasting tool to improvement their own activity. However it demands depth assortment analyzing and also it demands supporting the processes of automated forecasting by forecasting processes based on quality and mixed methods.
Originality/value: The value of following article is showing the new function of logistics enterprise which is demand forecasting. It could be also a value added activity which logistic operator could offer to their customers.

Keywords: distribution network, forecasting, logistics operator, R software.

Category of the paper: Case Study.

1. Introduction

Following article is aimed to showing the possibility of automated demand forecasting tool in logistic enterprise. It assumes testing results in created forecasting algorithm in chosen distribution network. Main feature of these network is the fact of logistic operator occurring. Logistics operators are one of the market trends nowadays. Logistics, which is entrusted to external, specialized entities, is referred to as outsourcing or contract logistics (Murpy, and Wood, 2011). It is important, according to Krawczyk, to don't identify contract with outsourcing, because it is no synonymous with permanent function transferring to external unit (Krawczyk, 2019). Transferring means ordering to specialized external entity some logistics functions. The most common directions o of outsourcing are (Bendkowski, 2008): IT, HR, distribution, logistics, finance and accountancy.

Logistics operator is defined as contract service provider, who is acting to maximum use of assets and improving operational activities (Skowron-Grabowska, 2011). He is a logistics service provider who provides variable range of logistics activities in the name of manufacturer or retailer. The decision to use operators' services is often based on strategic considerations, when the company recognizes that one or more elements of its business must change (Murphy, and Wood, 2011). Outsourcing a certain range of service to operators gives manufacturers opportunity to constantly improve their products and quality.

2. Forecasting as a new logistics operator function

Operator's competition in nowadays market takes place mainly not by offering the lowest price, but by ensuring the visibility in supply chain, reliability and positive attitude to innovations (Cichosz, 2018). Additionally, there is a possibility, that operators act a main role in configuration of whole distribution networks. They can take a management decisions connected in ex. with transportation management, distribution, customer service, warehousing and other activities connected with continuous improvement. Customers are striving for more and more advanced services, which are offered by operators. In contract logistics operators' type of 3PL (Third-Party Logistics) play major role. 3PL is an external organization which ensure realization of logistics function (Marasco, 2008). They are providing variable services. To the most common it could be included services as: external transportation, negotiating and concluding transportation' contracts, warehousing or load consolidation (Murphy, and Wood, 2011). Some of logistics operators are extended their services by complementary services (like products assembling or co-packing). Major of 3PL definitions approved that the main aim of these entities is providing the logistics services, but in author' opinion, they could also provide more sophisticated and going beyond logistics services.

One of trends in logistics trade is increase of services complexity and demand for logistics services packages (LSP) (Zelowski et al., 2018), which are often referred to as bundled services. This trend also concerns one of the basic service providing by operators – transportation and forwarding services, which are enclosed by the range of variable accompanying activities (Witkowski, and Kiba-Janiak, 2012). Enterprises in networks more often choose to collaboration enterprises which offer more than one service. It could be draw a conclusion that logistics operators could be more competitive by offering services complementary with basic logistics services which could be also a demand for products forecasting. Demand forecasting for some authors is considered as one of the major area of machine learning application (Hirt et al., 2020), which is one of the most important trends in nowadays science. Forecasting skills of logistics operator was considered in the literature a skills which could support logistics operator in inventory management in spare parts (Ayiomamitou, 2016; Dombi et al., 2018), in prediction of transportation service demand (Grzelak et al., 2019), in forecasting dedicated to own fleet optimization (van Aarde, 2017) and in forecasting supporting last mile deliveries (Sirikulvadhana et al., 2019). However, forecasting proposed by author, assumes complex solution conneted with demand for products forecasting for whole distribution network. Main idea of these conception is transfering the function of centralised forecasting to logistic operator who is acting in distribution network (Kmiecik, 2020). In following article is showed a conception of forecasting tool which could be implemented in logistic company and which could be used for automated time series forecasting.

3. Research methodology

Forecasting tool, which could be implemented in chosen logistic operator activity, was created in programming language R. R language is software intended to statistical calculations. In following article the conception of forecasting script integrated with operator WMS (Warehouse Management System) was showed. The main aim of these tool is automated demand for products forecasting based on time series of particular products releasing database. General assumptions of script was shown in figure 1.

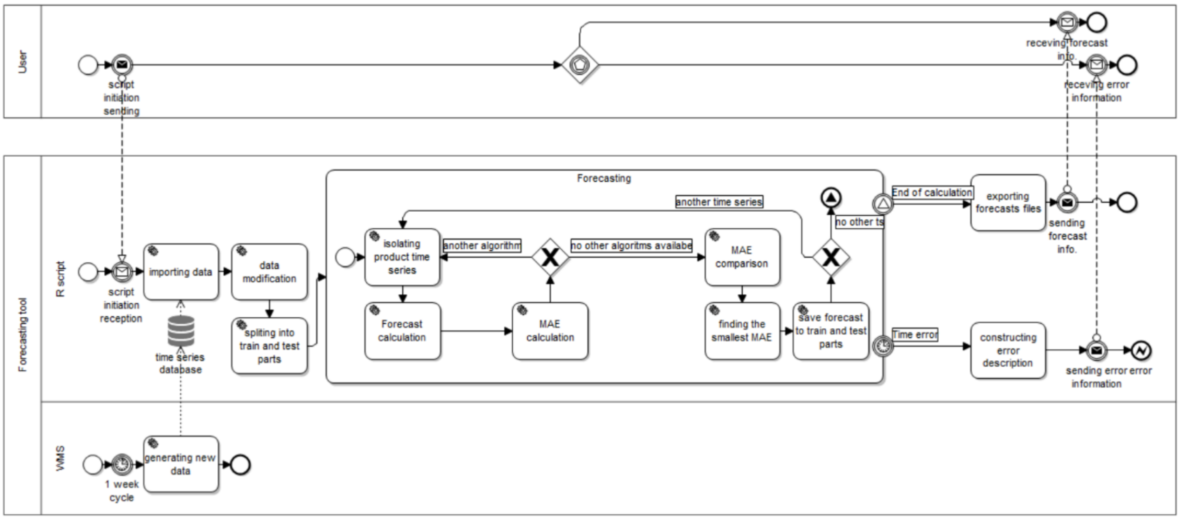

Figure 1. Process of forecasting tool work in BPMN 2.0 notation.

Tool is integrated with operator' WMS. New data was sent periodically – once per week. Data, after user initialization, are imported to script with actually database. In the next step data are modified. First modification includes files format adjusting to R requirements and removing outliers and cleaning the time series. Time series to cleaning are selected based on variation index, where time series with too much value of that index are clean. In the next stage time series are dividing to train and test parts. In train parts algorithms adjusting the calculations and in test parts the results of adjusting are tested. Whole forecasting process takes part in the loop individually for each products. Results to further analysis are chosen based on minimum MAE (Mean Absolute Error) values. After calculation and choosing proper results based on MAE forecasts are exported to user readable format.

Research sample on which performance of presented tool was tested consist of 22 distribution networks. These networks are characterized by the fact of logistics operator occurrence. This operator manage his own WMS and has the fully access to data contained therein. Data take into analysis reflect daily products releasing, forecasts are calculated in 42 days horizon with weekly data updating. Table 1 shows short characteristic of considered networks.

Table 1.
Brief characteristic of distribution networks

DN no.*	Food or non-food	General products	number of products	DN no.*	Food or non-food	General products	number of products
1	food	pastas	90	**12**	non-food	cosmetics	267
2	food	meat	150	**13**	non-food	cosmetics	427
3	food	sweets	38	**14**	food	sweets and snacks	779
4	non-food	household chemicals	691	**15**	non-food	household chemicals	221
5	non-food	electrical products	42	**16**	food	baby food	607
6	non-food	perfumes	509	**17**	food	beverages	86
7	food	sweets	75	**18**	food	bio-food	110
8	food	beverages and bakes products	510	**19**	food	snacks and sweets	768
9	non-food	toys	935	**20**	non-food	construction stuff	447
10	non-food	tobacco products	773	**21**	non-food and food	cosmetics and food	1917
11	non-food	tobacco products	283	**22**	food	sweets	254

*DN no. – number of distribution network

Distribution networks are classified in 2 basic groups (based on main subject of material flows) - food and non-food. Additionally there was also specified main range of assortment, which is the subject of material flows and products quantity. Forecasted and real values are the values in the minimal logistics units (usually in cartoons) which go to the retail points.

4. Results

By using created tool the daily forecast to 2 further weeks was calculated. To simplify results presentation, the values of forecasts was aggregated to week values and showed in table 2.

Table 2.
Forecasts results in two weeks period

DN no.	Week 1			Week 2		
	Real	Forecast	Deviation	Real	Forecast	Deviation
1	27 590	40 177	**45,62%**	36 804	36 097	**1,92%**
2	9 377	12 035	**28,35%**	33 249	12 944	**61,07%**
3	11 760	10 955	**6,85%**	7 501	10 779	**43,70%**
4	320 324	375 991	**17,38%**	228 325	318 367	**39,44%**
5	9 656	9 016	**6,63%**	11 460	8 141	**28,96%**
6	8 994	10 345	**15,03%**	9 785	18 852	**92,66%**
7	21 007	30 467	**45,03%**	58 930	33 604	**42,98%**
8	386 905	668 437	**72,77%**	384 185	698 745	**81,88%**
9	126 149	80 747	**35,99%**	143 793	98 738	**31,33%**
10	3 902 969	3 982 563	**2,04%**	3 060 298	4 141 224	**35,32%**
11	13 486	22 802	**69,08%**	13 718	23 896	**74,20%**
12	520 547	540 570	**3,85%**	362 398	547 581	**51,10%**
13	535 431	557 476	**4,12%**	408 431	478 386	**17,13%**
14	349 621	374 063	**6,99%**	348 128	406 145	**16,67%**
15	58 087	127 727	**119,89%**	276 461	134 661	**51,29%**
16	306 767	334 436	**9,02%**	407 690	365 500	**10,35%**
17	37 771	50 366	**33,35%**	42 249	54 877	**29,89%**
18	88 922	149 935	**68,61%**	269 603	150 101	**44,33%**
19	5 595 450	2 292 048	**59,04%**	8 968 250	3 810 589	**57,51%**
20	36 017	37 791	**4,93%**	24 781	34 632	**39,75%**
21	3 229 510	3 557 618	**10,16%**	3 552 655	3 587 030	**0,97%**
22	149 222	168 859	**13,16%**	182 301	169 669	**6,93%**

Additionally, in figure 2 was also showed summary results (aggregated to 2 weeks). These results was presented in the radar chart. Numbers around the chart perimeter show the number of distribution network. Percentage values in the chart show forecasts deviation from real values in the period of 2 weeks.

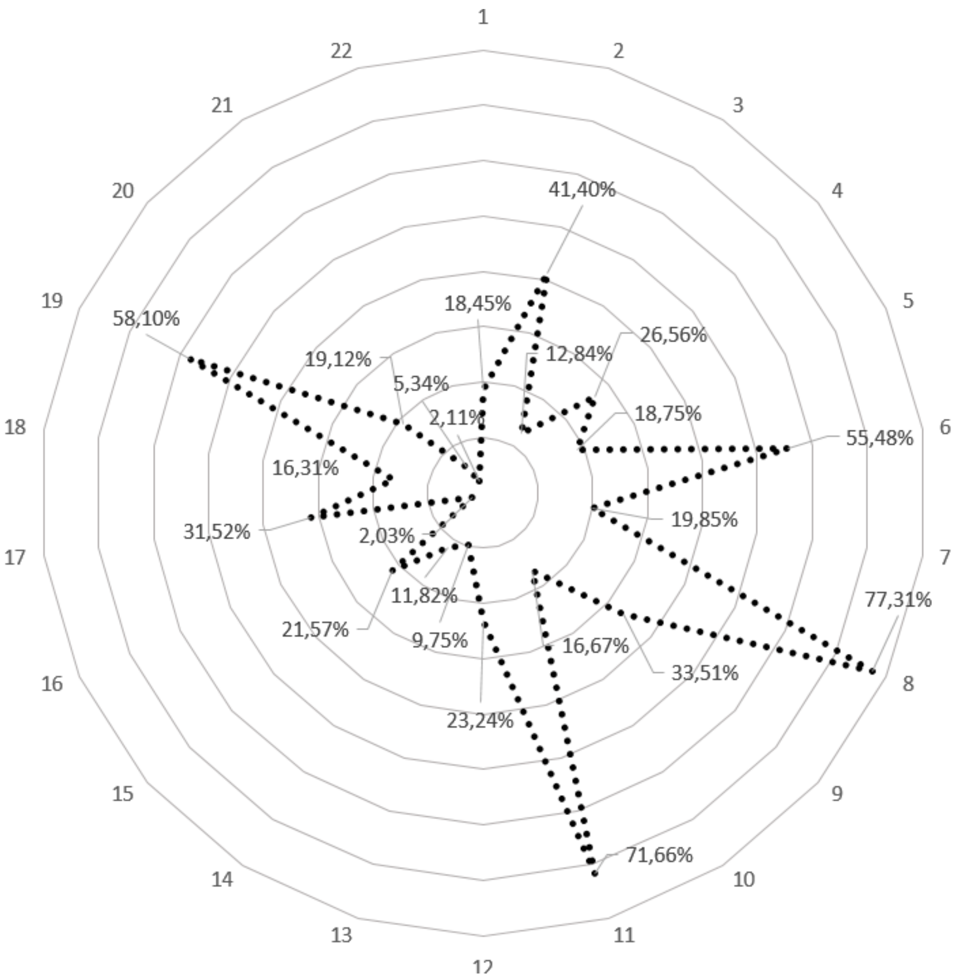

Figure 2. Total forecasts deviation from real values (2 week period).

In presented chart and table it is visible that in some of distribution networks operator could make forecast using created tool. The networks that tend to accurately forecast demand over the period of two weeks are: no. 16. baby food, no. 22. sweets, no. 21. cosmetic and food and no. 13. cosmetics. Deviations in this networks was lower than established 10% and was adequate: 2,03%; 2,11%; 5,34% oraz 9,75%. Networks which at this stage show high forecasting abilities and the forecasts deviation from the real values is less than 20% are: no.14. sweets and snacks (11,82%), no.3. sweets (12,84%), no.18. bio-food (16,31%), no.10. tobacco products (16,67%), no.1. pastas (18,45%), no.5 electrical products (18,75%), no.20. construction stuff (19,12%) and no.7. sweets (19,85%). In the rest of networks forecasts deviations are larger than 20%. Forecasts results, in author opinion, could be more accurate after using additional assortment grouping and exclusion from automated forecasting products from Z group (according to XYZ classification). Forecasts for these products could be calculated using an example quality or mixed methods.

5. Conclusion

The article reached the main goal. It showed the possibility of implementation and usage of forecasting tool in logistic company acting in distribution network. Tool created in R language allowed to automated time series forecasting based on database integrated with WMS.

Testing the tool on selected distribution networks indicated that a logistics company can support its activities with such a tool. Tool implementation could result in improved operational work by better planning and adjusting activities to forecasts level. Currently logistics operator based activities on experts experience and conjectures, so using tool based on statistical calculations could improve logistics operator work and could be the value added to their service recipients.

Additionally to improve the tool it is necessary to do results analysis individually for each product. It is also necessary to XYZ classification according to forecast accuracy and forecast ability. After such activities should be separate products which has high ability to automated forecast based on mathematical calculation. For the rest of products it should be adjusted other ways of forecasting, based on example on quality or mixed methods.

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