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AUTOMATION OF WAREHOUSE RESOURCE PLANNING PROCESS BY USING A CLOUD DEMAND FORECASTING TOOL

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Purpose: Research paper is an extension of the concept connected with demand forecasting function acquisition by logistics operators in the whole distribution network (concept is considered among others in the following papers: (Kmiecik, 2021a, 2021b, 2020). The concept of centralized forecasting assumes that a logistics operator, whose attributes coincide with the features selected through analysis of forecasting-able entities in the distribution networks and flagship enterprises, is able to take over the forecasting function for the whole distribution network. Paper, which is based on the mentioned concept, shows one of the first stages of its implementation. This stage is the implementation of the forecasting tool in the logistics operator's actions to support his operational activities. Currently, the logistics operator doesn't conduct the forecasting activity, but there are attempts aimed at implementation of forecasting tool and increasing the offered services' added value level. Operational activity, which will be first to be supported, is the process of planning the warehouse resources. Mentioned resources concern the human and internal transportation resources, which are needed for fulfilling the processes connected with SKU (Stock Keeping Units) releasing from the warehouse. The main paper purpose to examine the concept the of automated cloud-based resource planning process at the selected 3PL entity which provides logistics services to wide range of manufacturers in the distribution network using the computer simulation model with comparison with the current resource planning process.

Design/methodology/approach: Following research paper based on analysis the survey results and analyzing the simulation results. In the survey were tested the warehouse managers which are responsible for resource planning process. The analysis provides the general requirements of managers about resource planning process supported by automated cloud-based demand forecasting solution and information about expected forecasting tool accuracy. In the paper there were also created two simulation models based on BPMN 2.0 standard. First model reflects the current shape of resource planning process and was created to compare to the second, improved model. Improved model includes the examining of automated cloud-based resource planning solution.

Findings: The main expectations of 3PL operational managers about usage the demand forecasting tool is to support of warehouse resource planning. They also state that the expected accuracy of such a tool is the weekly MAPE not greater than 5%. The main benefits of proposed solution are the time decreasing, increasing the level of automation, showing the main areas when the agile point of view should be implemented and show the perspective of resource possibility of usage in the different activities (beside the resource planning process).

Originality/value: Automation and fully cloud integration will allow to reduce the process time more than 60% (in total and in average one process time). There are also some disadvantages of proposed solution which could be reduced by using other trends connected with Industry 4.0 development and by developing the collaborative strategies of the particular nodes of distribution networks.

Keywords: logistics operator; distribution network; warehouse management; demand forecasting; BPMN 2.0 model.

Category of the paper: research paper.

1. Introduction

Internal logistics is commonly state as the key of the business (Krajovic et al., 2018), for ensure the quick and faster supplies, for price stabilization and bulk breaking there is a necessity of using a proper warehouse infrastructure (Pandain, 2019) and efficient usage of warehouse resources. Nowadays, the third-party logistics service providers (3PL) needs to be more and more competitive. There is a huge amount of enterprises and the trend of logistics services outsourcing grows continually. Especially in Poland, where the logistics sector has got a very high share in tonne-kilometers in European Union in 2019 (16,4%) (Koliński, Werner-Lewandowska, 2021). The third-party logistics service providers need to be more competitive, To achieve high level of competitiveness, some me researches mentioned that the innovation openminded and aimed to value added creation is the most necessary thing (Chu et al., 2018).

One of the competitive advantages of enterprise is the need of creation a value by using resources properly (Aremu et al., 2018). Other of such a value added services could be, according to the author's opinion, extension of standard offered services by demand for products forecasting. This conception is called as centralized forecasting. The concept of centralized forecasting assumes that a logistics operator, whose attributes coincide with the features selected through analysis of forecasting-able entities in the distribution networks and flagship enterprises, is able to take over the forecasting function for the whole distribution network. Mentioned concept connected with demand forecasting function acquisition by logistics operators in the whole distribution network is considered, among others, in the following papers: Kmiecik, 2021a, 2021b and 2020. Proposed concept requires using the demand forecasting tool in the form of integrated with WMS (Warehouse Management System) IT tool. The future role of information technologies in supporting the management and control of logistics practices has been largely demonstrated (Ageron et al., 2018). Also, a lot of research and market trends expose the huge meaning of modern forecasting technologies like machine learning. Currently, there is a many usage of machine learning forecasting algorithms which considers a lot of prediction factors. Usually using a machine learning algorithm gives the better result just using a different forecasting method based only on historical data – it was confirmed by a lot of researches like Dou et al., 2021 and Spiliotis et al., 2020.

Usage of modern technologies by 3PL is a natural answer to current fourth industry revolution (Industry 4.0). In literature there were distinguished the basis of concept connected with logistics operators adjusted to Industry 4.0 reality. The Operator 4.0 has been defined as "a smart and skilled operator who performs not only cooperative work with robots but also work aided by machines as and if needed by means of human cyber-physical systems, advanced human-machine interaction technologies and adaptive automation towards human-automation symbiosis work systems" (Cimini et al., 2020). Nowadays, 3PL are striving with the issues of processes automation and usage of technological advanced solutions. Using automated processes offers a magnitude of benefits like better processes accuracy, consistency, reliability, costs reducing (Devarajan, 2018). A properly constructed information exchange system and the willingness to exchange information between different enterprises is the basis of an efficiently functioning enterprise network. A properly created information exchange system is also recognized by some authors as one of the key elements of the coordination of entire supply chains (Arshinder et al., 2008). Digital technologies and computer technologies that support the flows in networks are extremely important. We can distinguish, for example, electronic exchanges, which allow you to easily coordinate some transport activities (Karaenko et al., 2019). To automated the processes 3PL usually use the RPA (Robotic Process Automation) which could automate, among others, collection and processing the planning or demand data (Devarajan, 2018). It is really important especially when 3PL is enabled in building the distribution omnichannels strategies or improving processes according to e-commerce requirements. There are a lot of differences between traditional and e-logistics. For example, the 3PL should adapt processes from bulk to bulk & parcel shipment types or should be ready for less predictable orders flows (Erceg, Sekuloska, 2019). In this case the process automation could also help. The main differences and advantages of automated work is shown in table 1.

Table 1.
Differences about manually and automated warehousing work

Warehousing issue	Manually work	Automated work
Delay in procurement	2-3 hours	30-35 minutes
Delay in dispatched	1-2 hours	10-20 minutes
Errors commited in billing, procuring and dispatching	60%	10% due to network problems

Source: (Pandain, 2019).

Automated work in the warehouses, if it is planned and implemented properly, has a lot of benefits. On the other hand more manually work could for example (Barczak et al., 2020): extend the duration of the processes and time of making decisions, lower the managers' efficiency level and lower the level of process efficiency, increase the consumption of resources and increase costs or inhabit the stream of flows and reduce quality. Fully automation could be also one of the factors to improve demand planning processes, beacuse the quality in demand planning processes should be measured (among others like forecasts erros, inventory level, customer's service level and customer services performer on time) by process time (Szozda, Werbińska-Wojciechowska, 2013). This time could be reduced by process automation. One of the important elements to consider in contemporary considerations on coordination is the active inclusion of technological solutions in human activities and the ability to coordinate also the operation of these solutions. (Wang et al., 2020). Currently, the assumptions related to the creation and implementation of EDI (Electronic Data Interchange) are still important, but this is not only the only requirement for a well-designed information flow system. The broadly understood digitization pushes retailers and other enterprises operating in the network to adapt their business models to, for example, the modern conditions of multi-, cross- and omnichannels functioning (Rai et al., 2018).

Proper automation requires proper technology. One of such a technology, which provides also a huge amonunt of calculation power, data and information acqusition in the real time and possibility of integration and collaborative work is cloud technology. The usage of cloud-based solutions and the level of adoption of such solution affects positively on supply chain (Shee et al., 2018). Nowadays, there is even an up comming proposition of new Supply Chain Management (SCM) strategy called Cloud-based Supply Chain Management (C-SCM) (this connception is showed among others in Giannakis et al., 2019). C-SCM shows the trends connected with cloud tools usage in whole supply chain flows. One of the biggest cloud-based systems advantages from the perspecitve of management is on-demand services, broad network access, resource pooling, rapid elasticity and measured services (Giannakis et al., 2019). One of the concepts that is increasingly exploited both in terms of science and practice is the Digital Twin concept. This concept is based on a very strong digitization of activities and the possibility of creating an accurate computer model of the company's activity. Digital Twin, as some authors say, can also derive information from the demand forecasting system adopted by the company (dos Santos et al., 2020; Wright, Davidson, 2020), which gives grounds to think about the implementation of Digital Twin solutions as an additional element of demand management. Because of that is one of the main direction of processes and systems development in the 3PL activity.

Following research paper combines the conception of centralised demand forecasting, usage of demand forecasting tool by 3PL with the current meaning of process automation and usage of cloud technology (figure 1).

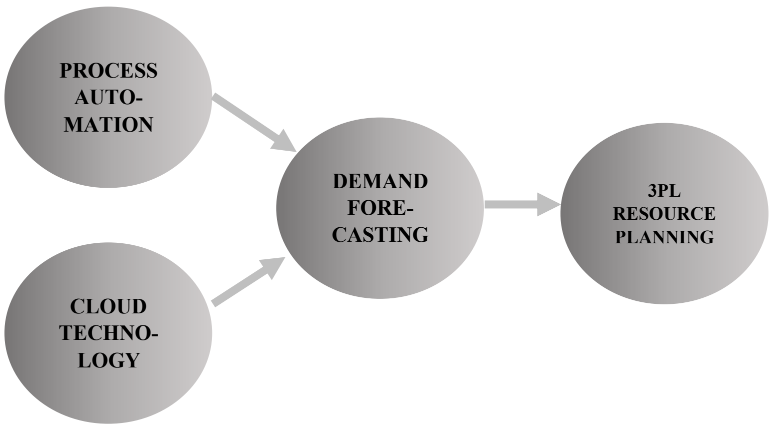

Figure 1. Research paper main areas.

2. Main research steps

Research paper focuses on the issue of resource planning processes in the example of selected logistics operator which could be described as 3PL. Main research steps are shown in the figure 2.

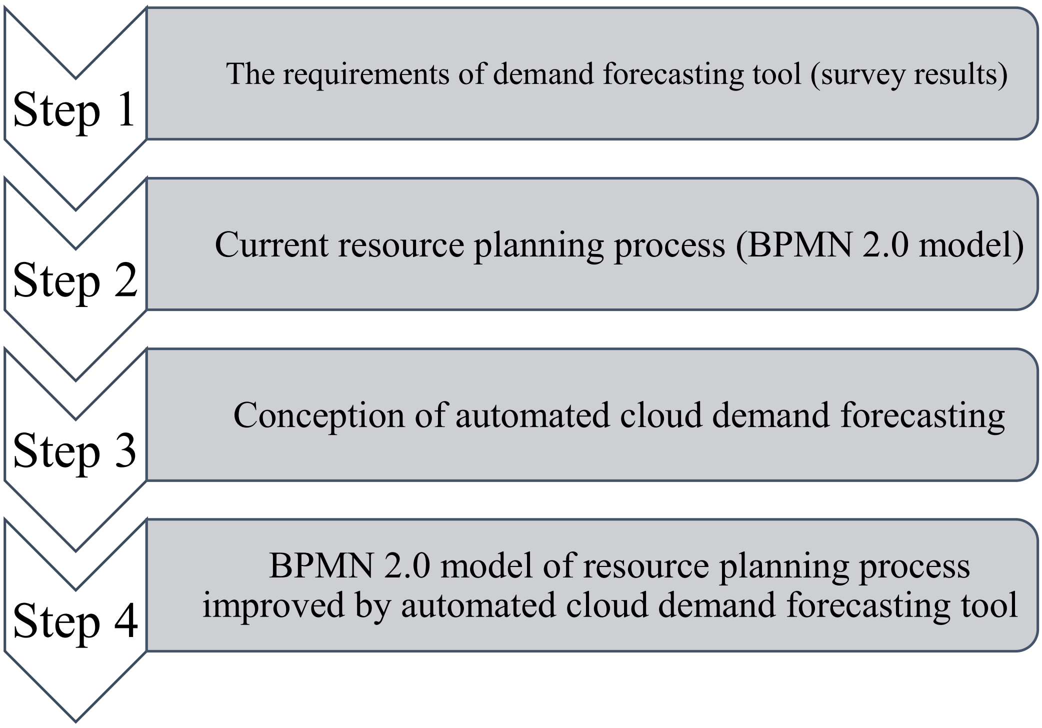

Figure 2. Main research steps.

Research was focused on the four main research steps. It answered to the two main research questions:

Q1: What are the main expectations of 3PL operational managers about usage and accuracy of demand forecasting tool?

Q2: What benefits will bring the automation from the perspective of resource planning process time?

The main hypothesis in the research was focused on following issue:

H1: Automated, cloud-based solution connected with demand forecasting used at simulation model will reduce the time of resource planning process at least by 60%.

Gaining the answers for research questions and verification of research hypothesis were achieved, at first, by analyzing the results of survey. The survey was created to check the main area of usage of demand forecasting tool in the chosen 3PL enterprise and to check the benefits which brings the proper implementation of the tool. Research sample are the warehouse operational, co-packing and co-manufacturing managers in the chosen logistics operator which provides logistics services (like warehousing, transportation, co-packing, co-manufacturing, cross-docking and processes engineering and implementation) to huge manufacturers.

The range of offered and handled SKUs is wide – from building materials, furniture to food. In the survey participates the 60 managers – 43 managers (72%) from Poland, 11 managers (18%) from Czech Republic and 6 managers (10%) from Slovakia. Mentioned managers are striving with the warehouse operational problems every day, they have a lot of practical experience and author think that is a proper research sample. The examined research sample states 82,19% (60 examined managers from 73 total) of all managers connected with managing the warehousing processes.

Currently the processes in the warehouse are not supported by any demand forecasting tool. Whole processes connected with resource planning are based on managers experience or, in the case of some small group of serviced manufacturers, on aggregated forecasts which are send by them. In the following research paper was created the simulation model of resource planning based on BPMN 2.0 (Business Process Modelling Notation 2.0). The sequence of the process was visualized in the BPMN 2.0. The process parameters connected with activities time, sub-sequences probability of decisions gates output, human resources were added to the BPMN 2.0 map and the computer model was created. To the computer model were added the simulation assumptions about simulation time and starting generators. Nextly, was showed the author's conception of cloud-based demand forecasting tool as an input to resource planning processes automation. This conception is based on the current research connected with the implementation tests of cloud-based forecasting in the activity of chosen 3PL and forecasts accuracy. In this case there were also created a simulation model which shows the benefits of automated resource planning.

3. Automation of warehouse resource planning process

3.1. Main 3PL operational requirements about demand forecasting tool (step 1)

Research sample are the warehouse operational, co-packing and co-manufacturing managers in the chosen logistics operator which provides logistics services manufacturers. In the survey participates the 60 managers:

- 43 managers (72%) from Poland.
- 11 managers (18%) from Czech Republic.
- 6 managers (10%) from Slovakia.

Mentioned managers strive with the warehouse operational problems every day, they have a lot of practical experience and author thinks that is a proper research sample. The examined research sample states 82,19% of all managers connected with managing the warehousing processes in the considerate case of 3PL.Whole three questions are the type of closed questions with one possible answer. Last question was created based on the answer about the main utility area of demand forecasting tool.

First question (figure 3) was connected with the main utility area for demand forecasting tool in the operational warehousing activity of 3PL.

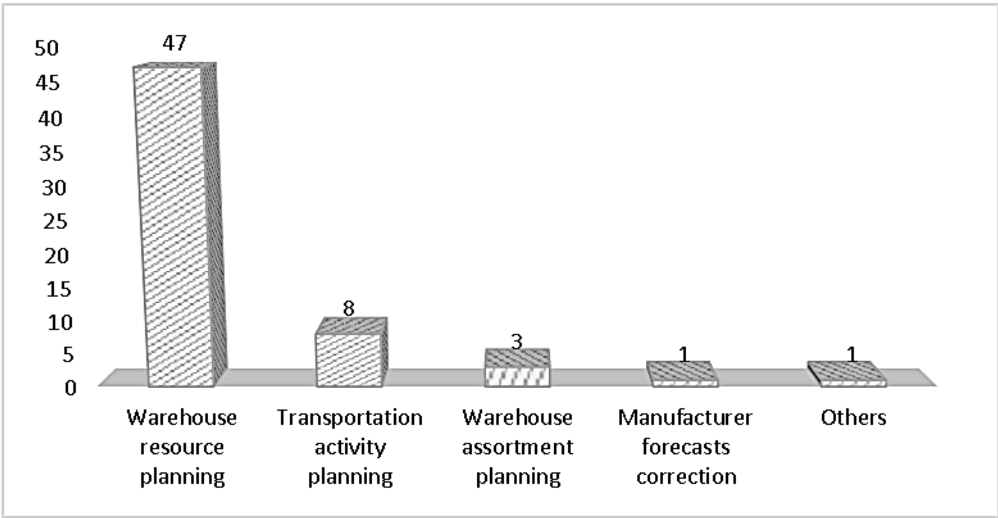

Figure 3. 1st question: in which area do you see the greatest opportunity to use the demand forecasting tool?

The 13,33% of answers were connected with usage of demand forecasting tool as a tool for support the transportation activity. It could be achieved by forecasting the distribution quantities in pallet places. Few of answers is connected with usage a tool for support the warehouse assortment planning (5,00% of answers) where the demand forecasting tool could be used for support the ABC assortment analysis or two-criteria analysis ABC/XYZ. There is also a possibility of use the forecasting tool to correct the manufacturers predictions, but this option states just about 1,66% of answers. The vast majority of answers (78,33%) were connected with usage of forecasts results as a tool of warehouse resource planning support. Warehouse resource planning, in the following questionnaire, was understood the estimation in advance the proper quantity of warehouse workers and warehouse infrastructure (like forklifts or data collectors) to handling the current warehouse activity. According to questionnaire and authors' opinion, the demand forecasting tool in the activity of 3PL should focus mainly on this need.

Second question (figure 4) focused on demand forecasting tool accepted accuracy. The accuracy mentioned in following question is the MAPE (Mean Average Percentage Error) to one-week period. MAPE is calculated as follow:

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right| * 100\%$$

where:

$t = 1,2, \dots, n$ – considered periods.

A_t – real warehouse distribution quantity in period *t*.

F_t – forecasted warehouse distribution quantity in period *t*.

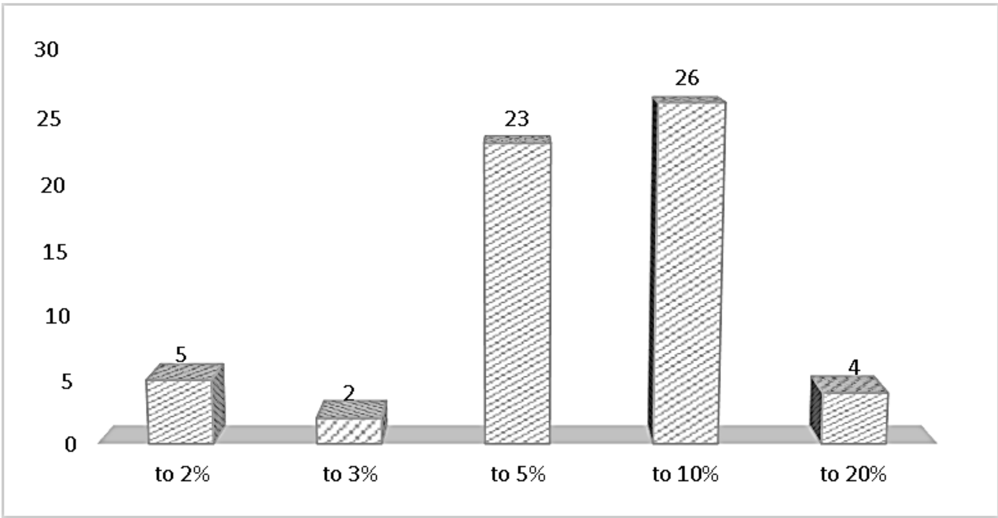

Figure 4. 2nd question: for which maximum error level (based on weekly MAPE) the forecasts are useful?

Second question was focused on the maximum possible error, which will be accepted in operational activity of 3PL. Based on answers (figure 4) it could be state as follow:

- Weekly MAPE in the maximum level of 2% will meet the 100% requirements.
- Weekly MAPE in the maximum level of 3% will meet the 92% requirements.
- Weekly MAPE in the maximum level of 5% will meet the 88% requirements.
- Weekly MAPE in the maximum level of 10% will meet the 50% requirements.
- Weekly MAPE in the maximum level of 20% will meet the 7% requirements.

Based on presented results as a key accuracy level for operational needs, in the following research paper, the 5% was assumed.

Presented questionnaire analysis gives the possibility to answer the first research question (Q1: What are the main expectations of 3PL operational managers about usage and accuracy of demand forecasting tool?). The main expectations of 3PL operational managers about usage the demand forecasting tool is the supporting of warehouse resource planning. They also state that the expected accuracy of such a tool is the weekly MAPE not greater than 5%.

Based on the results of question one the potentially time saving in resource planning were examined (figure 5).

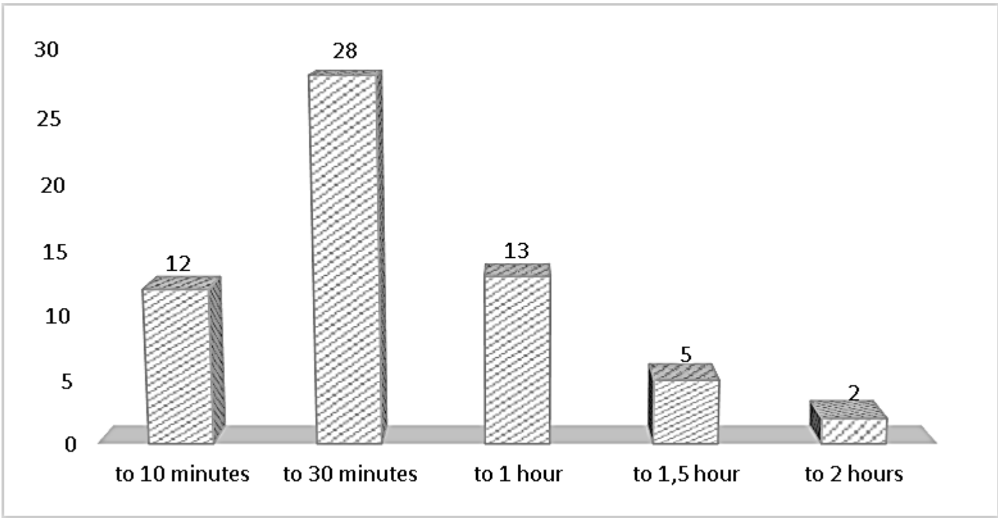

Figure 5. 3rd question: how much time do you spend on resources allocation during resource planning process?

Third question has on purpose to determine the current time which managers spend on resource allocation during resource planning process. Based on this question it could be state that about 70% of managers spend above 30 minutes for this activity. Additionally, according to sum of ratios divided into sum of expected results, it can be concluded that the proper creation, implementation and integration of forecasting tool will decrease the managers workload in this activity in average level of 29,83 minutes. Which gives in potential time saving in one week (based on 5-days work system) in the level of about 149,15 minutes, in one month (based on 4-week month assumption) in the level of about 9,94 hour. The results from mentioned question analysis will be taking into account also during simulation. It is worthly to mention that even that the resource planning is not a value added activity it is an activity which is necessary to making a proper warehouse processes. So, shortening the resource planning process will have influence on whole 3PL activity.

3.2. Resource planning process in the selected logistics operator (step 2)

Warehouse manager is the main swimlane involved in the resource planning process. The process begins and ends in this entity. There are two main sequences of process flows – first when the manufacturer sends the prediction of sales (about 15% of situations) and second when the manufacturer doesn't sent the predictions (about 85% of situations). When the manufacturer sends the prediction then manager checks the latest database with predictions and if there is an available update (about 20% of situations in this sequence) there is a checking the fulfillment and compatibility with contract statements and possible activity ad-hock with manufacturer. If manufacturer doesn't send the forecasts, the warehouse manager checks the historical data and try to estimate the future value of SKU releasing quantity. After this there are a resource allocation activity (based on the survey the author assumed the time of this activity is in the range of 20-40 minutes). When the resources are allocated the information is sharing with team leaders to make possible modifications. Whole model in BPMN 2.0 is showed in figure 6.

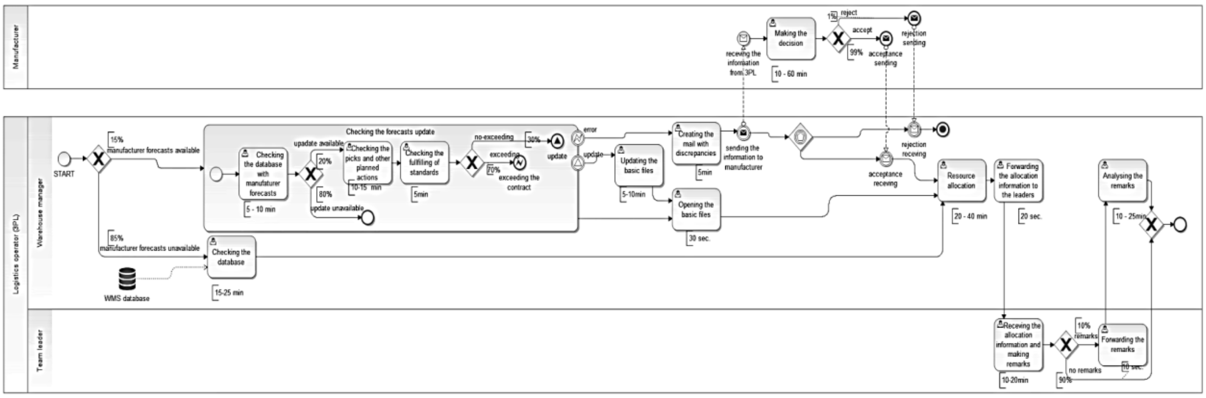

Figure 6. Resource planning process model in BPMN 2.0 (high quality map is available at: https://tiny.pl/9g2p6, 21.09.01.

Times of particular activities to simulation model is estimated based on author's participant observation of the process and the results is showed in table 2.

Table 2.
Activities times parameter to the BPMN 2.0 model

No.	Swimlane*	Activity	Time**	No.	Swimlane*	Activity	Time**
1	WM	Checking the database with manufacturer forecasts	5-10 min	**8**	M	Making the decision	10-60 min
2	WM	Checking the picks and other planned actions	10-15 min	**9**	WM	Resource allocation	20-40 min
3	WM	Checking the fulfilling of the standards	5 min	**10**	WM	Forwarding the allocation information to the leaders	20 sec.
4	WM	Checking the database	15-25 min	**11**	TL	Receiving the allocation and making remarks	10-20 min
5	WM	Updating the basic files	5-10 min	**12**	TL	Forwarding the remarks	10 sec.
6	WM	Creating the mail with discrepancies	5 min	**13**	TL	Analyzing the remarks	10-25 min
7	WM	Opening the basic files	30 sec.	***WM – warehouse manager; TL – team leader; M - manufacturer **in the case of time range the simulation time is calculated from normal distribution**			

Main assumptions about simulation scenario were as follow:

- One work shift which takes 8 hours, there are 5 workdays in one week.
- Resources are planned once per day starts at 08:00 am. In the simulation are considered the standard month (without any holidays, 22 workdays).
- Simulation consists of planning resources in 20 warehouses simultaneously, so each simulation starts at 08:30 am generates the 20 sequenced runs in the considerate 1-month period.

- In the one process sequence are involved 1 Warehouse Manager (WM) and 2 Team Leaders (TL), so daily sequence generates the usage of 20 WM and 80 TL. The availability of WM is 90% per one process run with 10 minutes break in the random moment of workday. The availability of TL is 85% with 10 minutes break in the random moment of workday.

The general results of simulation are gathered in the table 3.

Table 3.
General simulation results – resource planning process

Parameter	Parameter description	Parameter value
Total time	Total process time of simulation	611,62 h
Total transactions	Total number of ran sequences in the simulation	440 transactions
Average process time	Total time divided by total transactions	1,39 h
Manufacturer activity	Number of transactions flowed by manufacturer pool	4 transactions
Number of rejections	Number of situations when the manufacturer did not agree with additional fee	2 times

Whole simulation takes 611,62 hours, total number of sequences ran through it was equal to 440 (20 warehouses daily planned resources in the range of 22 days). Average process time is equal to 1,39 hours. Manufacturer was involved into process 4 times and the process ends in the different way than standard twice. During the simulation there were also checked the chosen indicators connected with process resources (WM, TL and M) usage (figure 7).

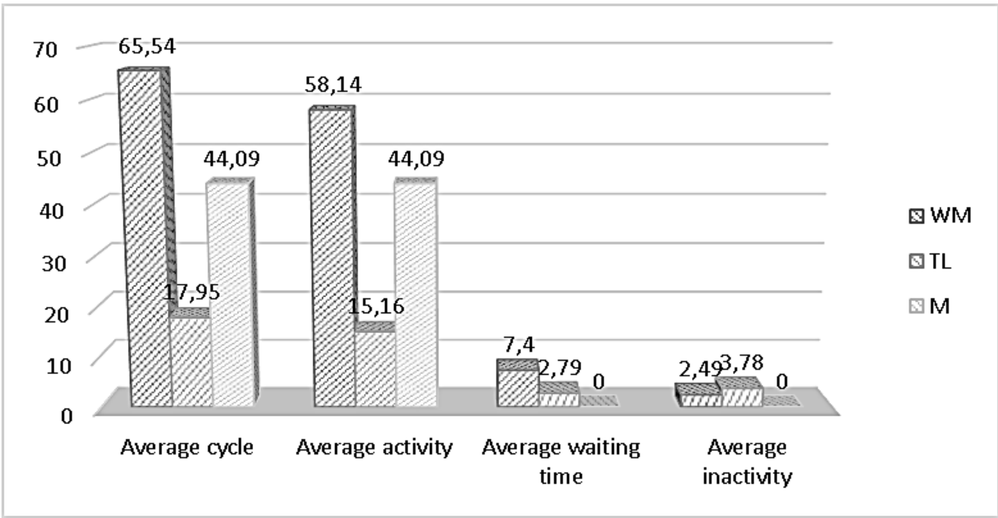

Figure 7. Simulation results connected with process resources.

Average cycle is the time period of transactions done in the particular resources for WM it takes 65,54 minutes, for TL 7,95 minutes and for M 44,09 minutes. The most workload resource is the WM, but the fact of occasional involving to the process of M is also increased the total time of process. The average cycle consists of average activity (time of active processing the transaction by the particular resources) and average waiting time (time of waiting of transaction caused by inactivity, blocked or waiting for resources). Average inactivity is the time when the resources were scheduled, but there were not available in sequence. Simulation also allowed to distinguish the activities average time of waiting for resources (average waiting for resources). It is connected with process delays indicated by the sequences stops. The six main activities which generates about 90% of average waiting for resources in the process is shown at figure 8.

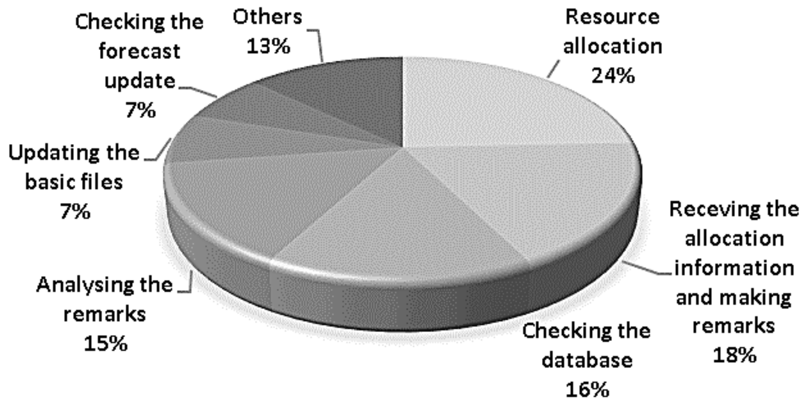

Figure 8. Average waiting for resources – activities.

The activity with the largest average waiting for resource indicator is resource allocation. In the top of such activities there is also a receiving the allocation information and making remarks by TM and checking the database by WM – this whole activity is connected with necessity of manually establishment of warehousing resources with no supports by statistical analysis system of resource planning. The simulation approved the survey results about the necessity of support this area by demand forecasting system.

3.3. Cloud demand forecasting tool as a tool for resource planning automation (step 3 & 4)

Proposed solution assumes implementation of cloud-based forecasting tool and usage the standard indicators about warehouse resources capacity to automate the process of resource planning. Cloud technology will provide the possibility of improve the calculation power in the process of forecasts creation. The proposed sequence of the process is shown in figure 9.

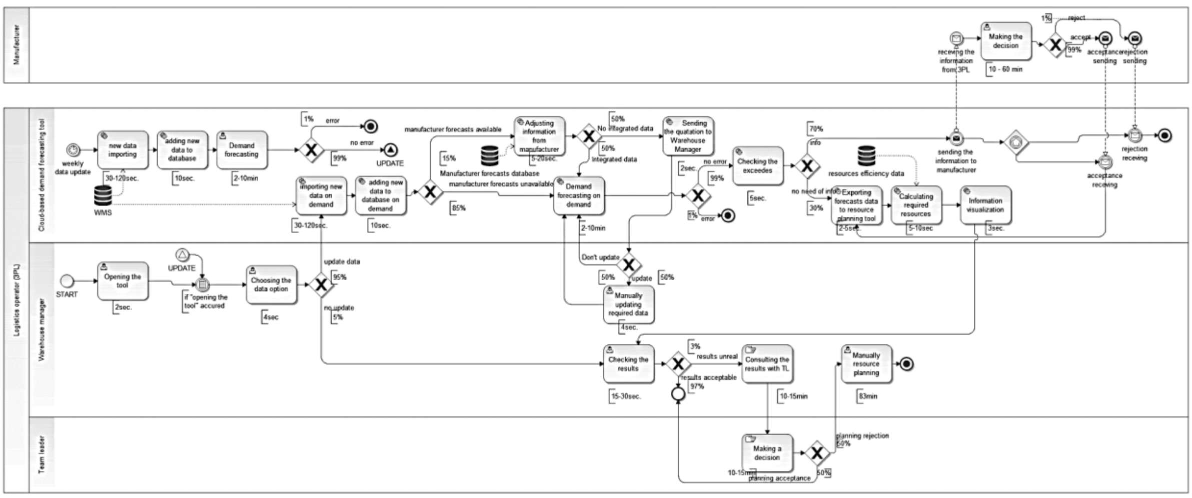

Figure 9. Cloud-based resource planning process supported by demand forecasting tool model in BPMN 2.0 (high quality map is available at: https://tiny.pl/9g6fv, 21.09.01

The process assumes the connection of WMS databases with cloud queries and usage of always updated data from warehouse operations. The forecasting tool is integrated with the database and forecasts will be updated automatically once per week. Core of the process assumes the running the process on demand (95% of cases), but there is a possibility of acting on previous generated forecasts. Table 4 consists of the activity's times parameter description.

Table 4.
Activities times parameter to the cloud-based resource planning process BPMN 2.0 model

No.	Swimlane*	Activity	Time**	Kind ***	No.	Swimlane*	Activity	Time**	Kind ***
1	CDF	New data importing	30-120 sec.	R	11	CDF	Calculating required resources	5-10 sec.	A
2	CDF	Adding new data to database	10 sec.	R	12	CDF	Information visualization	3 sec.	R
3	CDF	Importing new data on demand	30-120 sec.	R	13	M	Making the decision	10-60 min	A
4	CDF	Demand forecasting	2-10 min	R	14	WM	Opening the tool	2 sec.	A
5	CDF	Adding new data to database on demand	10 sec.	R	15	WM	Choosing the data option	4 sec.	A
6	CDF	Adjusting information from manufacturer	5-20 sec.	A	16	WM	Manually updating required data	4 sec.	A
7	CDF	Demand forecasting on demand	2-10 min	A	17	WM	Checking the results	15-30 sec.	A
8	CDF	Sending the quotation to WM	2 sec.	A	18	WM	Consulting the results with TL	10-15 min	A
9	CDF	Checking the exceeds	5 sec.	A	19	WM	Making a decision	10-15 min	A
10	CDF	Exporting forecasts data to resource planning tool	2-5 sec.	A	20	WM	Manually resource planning	83 min	A

*WM – warehouse manager; TL – team leader; M – manufacturer; CDF – cloud-based demand forecasting tool
**in the case of time range the simulation time is calculated from normal distribution
*** A – assumed time based on expert experience, R – assumed time based on the current part of process tested in the warehouse operation

In the order of answering the second research question the time parameter were analyzed. The simulation scenario was the same like before, the same amount of transactions with the same sequences generations were tested. Activities times which were considerate during simulation were settled in the following way: some activities are tested right now and the time parameter was calculated based on experience of current work and some activities time were assumed based on expert experience. Whole times are shown as a process time when the workers were getting enough knowledge about that, so it did not include the managers and team leaders training. General results from simulation were shown in the table 5.

Table 5.
General simulation results – cloud-based resource planning process

Parameter	Parameter description	Cloud-based tool	Current solution	Increase (+) decrease (-) percentage
Total time	Total process time of simulation	102,54 h	611,62 h	-83,23%
Total transactions	Total number of ran sequences in the simulation	440 transactions	440 transactions	0%
Average process time	Total time divided by total transactions	0,23 h	1,39 h	-83,45%
Manufacturer activity	Number of transactions flowed by manufacturer pool	63 transactions	4 transactions	+93,65%
Number of rejections	Number of situations when the manufacturer did not agree with additional fee	1 time	2 times	-100%

Total time of simulation is equal to 102,54 hours which states about 16,77% of basic time which will be possible to achieve using automated, cloud-based demand forecasting tool. Also, the average process time is lower (of about 83,45%) than in the case of standard resource planning process realization. However, the manufacturer activity in the case of automated tool is bigger, it is indicated by the agreement's issues. Whole picks, as a deviation from contract values, required the formal confirmation by manufacturer. Every time when the demand forecasting tool will recognize the picks in forecasted horizon it sends the information to manufacturer. According to the author's opinion, this situation will force the more agile approach to collaboration between 3PL and manufacturer. Results connected with influence of proposed cloud-based tool on resources used in the process are shown in the figure 10.

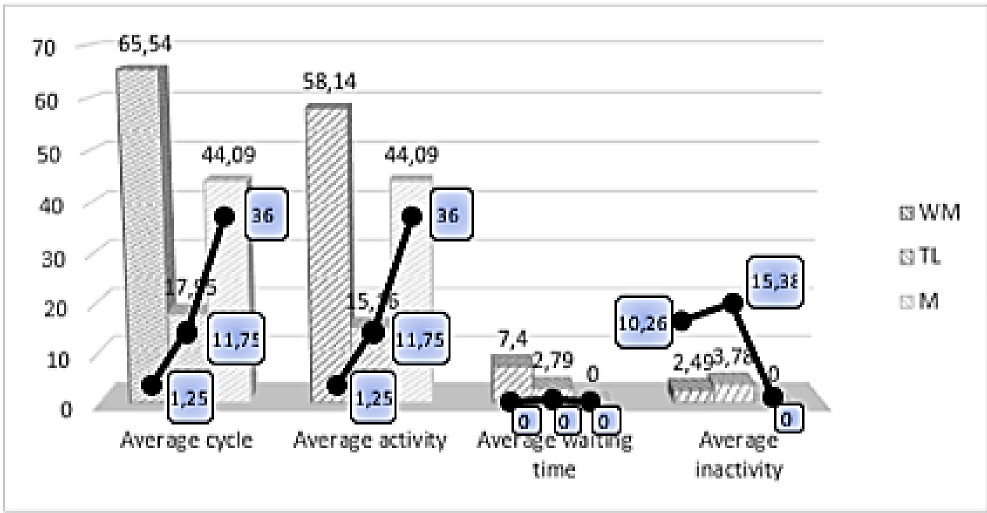

Figure 10. Cloud-based solution simulation results – influence on process resources.

Like it could be concluded from figure 10, the average cycle time of resources usage was decreased and it is equal to average activity time of resources. It means there is no waiting time of resources in queue. It was indicated by usage an additional pool of cloud-based demand forecasting system where the activities are automated computing and whole prediction and almost whole decision part is done automatically. One parameter which increases in the conception of automation is average inactivity of resources. It is connected with time shortage. In the author's opinion, the increasing value of this parameter should not be treated like disadvantage. More inactivity time, not connected with resource waiting in queues, could be used for support other activities which are done by particular resources.

Presented analysis allowed to answer the second research question (Q2: What benefits will bring the automation from the perspective of resource planning process time?). The main benefit is the time decreasing, increasing the level of automation, showing the main areas when the agile point of view should be implemented and showing the perspective of resource possibility of usage in the different activities (beside the resource planning process). There is also no fundamentals to reject the paper hypothesis (H1: Automated, cloud-based solution connected with demand forecasting used at simulation model will reduce the time of resource planning process at least by 60%). Like was presented, automation and fully cloud integration will allow to reduce the process time more than 60% (in total and in average one process time).

4. Conclusions

Presented research paper answered on two basic research questions. First of all, there were stated the main expectations of 3PL operational warehouse managers about usage and accuracy of demand forecasting tool. For that reason, managers opinions were examined by survey. According to this the managers see the greatest opportunity of tool usage in the process of warehouse resource planning, so they want to use demand forecasting tool results as an input to quantitative analysis of required human and material resources in the particular days of warehouse activity. They also required the accuracy level at the minimum MAPE level at 5% (it will cover 88% of manager expectations) in the daily forecasts. The automation- and cloud-driven improvement of the process was considerated by building and testing simulation models based on BPMN 2.0. There were built two simulation models (first connected with current process shape and second connected with usage of automated cloud-based demand forecasting to support the resource planning process) and both of them were tested in the same simulation scenarios about sequence generations, time and human process resources parameters. One of the most important improvement is the possibility of process time reduction. Using mentioned technologies, it will be possible to reduce the time of resource planning process more than 60%, which allows to accept the paper's hypothesis. What is worth mentioned the cloud-based solutions are usually very efficient (Kumar, Singh, 2019; Chou, Truong, 2019) in the case of IT infrastructure usage. Of course, the author, sees the both advantages and barriers of proposed solution. The most important of them, according to the author opinion, is shown in the table 6.

Table 6.
Brief SWOT analysis of proposed solution

Strengths	**Weaknesses**
-Automation and time reduction. -Huge cloud-based calculation power. -Fully data flows integration with WMS databases. -Decision making supported process. -Promoting of agile management.	-Necessary of modification of logistics contracts. -Data highly depended solution. -Risky data required from manufacturer to improve the calculations.
Opportunities	**Tears**
-Possibility of developing the demand forecasting algorithms with other large input data which could shaped the algorithms parameters. -Cloud & automation market trends. -Logistic 4.0 & Logistics Operators 4.0 market trends. -Easily to maintenance IT infrastructure.	-Manufacturer could feel moved away from demand planning. -Overfitting of algorithms connected with neural networks or machine learning (to fitted algorithms).

As was presented in the table 6 there an advantage of strengths and opportunities in the comparison with weaknesses and tears. One of the major advantages is automation and time reduction in accordance to contemporary market trends connected with implementation of Industry 4.0 solutions. There will not be also any issues with calculation power because of huge available cloud calculation power resources and pipelines calculation technologies which provides the possibility of calculate forecasts in parallel for huge number of manufacturers. Cloud technology provides also possibility to fully integration of input data possessing from WMS. Proposed solution will also provide the possibility of support the decision-making process by providing the warehouse managers necessary information about planned processes and predicted values connected with warehousing activity. Cloud-based solution will also implicate the need of promoting the agile approach to contract logistics with minimalize the formal regulations and maximize the collaboration with manufacturer. Opportunities to development the tool are possibilities of developing the demand forecasting algorithms due to nowadays highly advance forecasting methods which could increase 3PL innovative level. Opportunities to tool implementation are also current trends connected with cloud-based technologies, automation and Industry 4.0 where the companies are encouraged to implement the solutions in these areas. Cloud-based solutions are usually also easy in IT maintenance which is also an opportunity.

The weaknesses and tears are the areas in which proposed conception could be improved and the possible areas of future research. First of all, there is a necessary of modification of logistics contracts – logistics contracts provide the standardization which often replace the proper collaboration level between 3PL and manufacturer. To gain the best level of forecasts the proper collaboration between this and other nodes of distribution network will be required.

This solution is also highly depended on data, so if the input of data be not proper then the results also will be disrupted. On the other hand, the highly accurate data usually contains the data about planned picks, promotions or sales strategies which manufacturer could classified as risky data to share. In this case also the technology could help. In the author's opinion one of solution of this problem is blockchain technology, when it will be possible to use the blocks – hidden and public. In public block could be more general information connected with the data specific. In hidden block could be delivered the data directly to forecasting tool without sending their specific to the 3PL. The idea of connect the cloud technology with blockchain is currently considerate by the authors like Kumari et al. (2020). Research paper provides answers to created research questions and positively vitrificated the hypothesis.

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