Research Article

Opportunities of on-demand logistics operations

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Abstract

As a result of information technology and digitalization, it is possible to get to know the previous customer demands and more details. This allows companies to operate flexible and adaptive, more efficient logistics processes using the known demands. This is the basis of on-demand activities. However, in addition to understanding and using the tools, it is important to know the timeliness of the processes, because only in this way can the necessary tools be determined and applied effectively. In our article first we will examine the typical logistical demand processing processes. Based on these studies, we define a general demand fulfillment case study, which includes the characteristics of typical processes and formulates the risks associated with changes in demands and helps to develop adaptivity. The circumstances related to logistics are constantly changing due to the impact of digitalization. Practical solutions that have been thought to be rock-solid need to be reinterpreted in such a way that they can be implemented for the technical solutions of the future. Current production planning solutions operate on-demand planning. This includes (old) stocking concepts that want to ensure the number of raw materials needed for this type of design, but in many cases, this can result redundant and unnecessary high stock. The problem is the constantly changing on-demand supply of production, which requires a high level of IT support. On the other hand, only a very limited percentage of companies have systems or processes for providing highly automated care. As a consequence, production planning is forced to adapt its production programmed to the available stocks and processes. Thus, the role of information and the extent to which related analytics solutions are applied are appreciated in these processes, as they are the foundations of the entire organizational performance.

In our research, therefore, we focus on the processes by which we can help bridge the gaps between current production planning and supply. The goal of this paper to highlight the necessity of the on-demand operation optimization and the possible on-demand solutions.

Keywords: Logistics, On-demand, Operations

1. Introduction

Recent technological developments, an appreciation of the role of the Internet, an increase in the number of transaction channels, and the opportunities and positions of consumers have also been greatly strengthened. Until recently, the researchers ignored this, and its defining economic theories, set up space and time-dependent items only for consumer behavior [1]. By contrast, the changes of the present day paint a more nuanced picture of consumers. The Internet has allowed for consumer to buy the desired product anywhere and at any time, such as food, electronic devices and even car. With targeted advertising based on digital profiles, producers/producers no longer target individuals, rather than consumer groups, thus channelling consumer needs and purchasing stimuli. This market environment (also) and the opportunities provided by technology have also facilitated the uptake of flexible manufacturing technologies. This is what some researchers call personalized mass production [2]. However, there are still passive consumers who do not know or do not want to formulate their needs, they are satisfied with what is available in-store, i.e. the manufacturer/producer continues to manage the processes [3].

The totality of the above has strengthened the role of logistics since demand-based, fast and more accurate delivery demands cannot work without adequate logistical support.

Logistics systems must also adapt to this. In the vast majority of cases, it is enough to reorganize workflows, but above a certain level this is no longer enough and it is necessary to increase its support for physical processes. In our research, we try to organize demand-based order delivery processes to present a complex picture of the difficulties of the current processes. To achieve this, we highlighted four typical cases, which were analyzed in detail, thus revealing the differences between the mechanism of normal operation and the disturbances caused by unexpected demands. Building on these, we have identified the scope of the potential risks and their extent in the processes if they are unable to respond. We demonstrate the importance of adaptive adaptation in the field of logistical demand processing and service. And the delineated and precisely defined adaptation tasks already help to identify the development directions by which the objectives set will be made available. In doing so, we want to establish a framework that allows companies in different fields of logistics to adapt it effectively to their processes and meet the growing customer expectations by maintaining their efficiency.

2. The General Process Of Demand Service

In this study, we determined four cases that best illustrate logistics demand service processes. The cases are different, but by examining and analysing their processes in detail, we managed to set up a general demand service process, which we have not encountered in previous research. The 1. figure below illustrates the general main processes that provide a unified framework for the topic. Its advantage is that it can be applied to other logistics processes with minor modifications.

In terms of the demand service process, the first step is the demand appears from the customer to the server. This step can be broken down into further steps, as unlike standard processes, late orders or urgent requests may be received, but this also includes the modification of the customer's request before fulfillment. In the second step, procurement processes should be carried out if necessary to meet the demands. This step can also be broken down into further steps. We distinguish between procurement processes by the fact that procurement takes place at one or more stages. In addition, urgent and extra sourcing processes need to be handled separately even at extra cost to meet the demands.

In the third step, the processing of the demands begins, which can take place in parallel with the procurement process. Demands can be served from stock or procurement. Extra, urgent orders result in extra processing, which requires even extra labor and time. This is processing in parallel with the basic demands.

The fourth step is about routing, which is also a parallel process to demand processing. Based on the received demands, it is possible to determine what equipment is needed for delivery. It is mostly company dependent. An important task is a properly scheduled delivery, which depends on the production or picking tasks, and the steps need to be coordinated accordingly.

The delivery step includes the definition of the delivery time windows, as this is already defined during the communication with the carrier. It is an important decision to outsource the delivery or to complete it with your own equipment. In the case of production companies, material handling between the warehouse and the production units takes place.

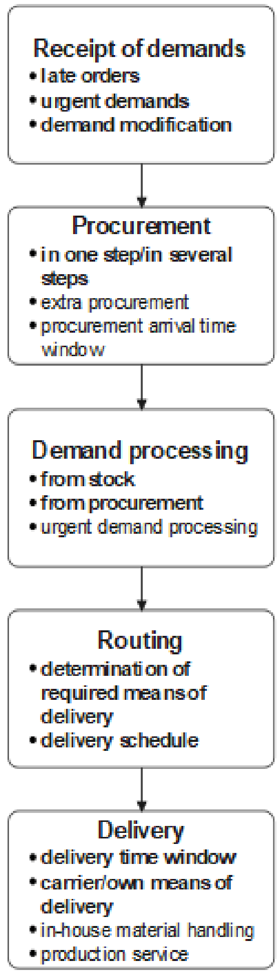
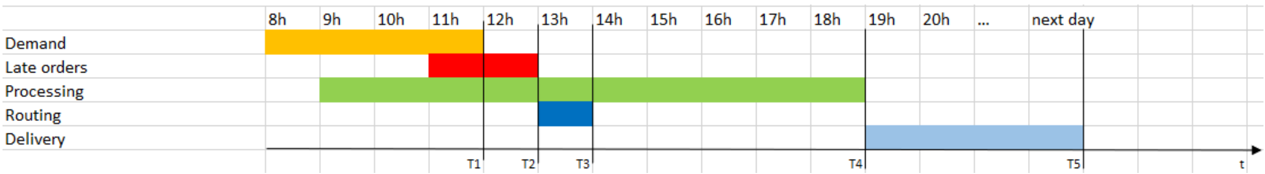


Figure-1 The general process of demand service

Using the Gantt diagrams below, four cases are presented that, without claiming to be exhaustive, reflect real, ordinary operations. The first three cases contain 2-2 Gantt chart, the first shows the ideal process, and the second shows how tasks change over time for certain unexpected demands. The fourth case shows the service of production demands. In addition to the basic operation, two cases are presented where different changes take place in the system.

2.1. Same-day webshop demand processing, next day delivery by courier service - parcel deliveries

This case illustrates the demand processing and courier service of webshop companies. In most cases the companies undertake to picking the demands on the same day and delivery on the next day if the orders are received by a certain date. The range of goods handled varies, but delivery takes place in units managed by courier service.

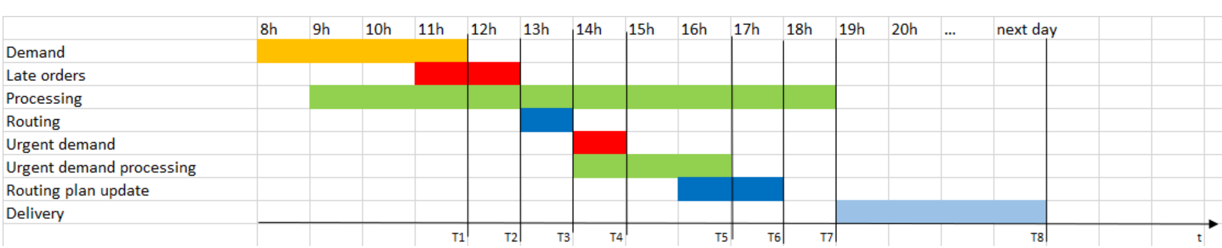


T1:Deadline for receipt of basic demands
T2:Deadline for receipt of late orders
T3:Deadline for the routing task
T4:Deadline for demand processing
T5:The parcel was delivered

Figure - 2 Ideal operation in 1. case

Based on the example, the ideal case is when demands arrive by 12 a.m. every business day. Late orders can be received until 2 pm, these will be fulfilled by the company at an additional cost to the customer. The processing of demands, which in this case covers the picking, sorting, packaging, document management, starts from 9 am during the receipt of the demands. Based on the requests received by 12 am, it is already possible to plan the ordering of the necessary equipment of transport and the reporting of package numbers. The processing of demands must be completed by the time the means of transport arrives and then handed over to the carrier at 7 p.m.

The ideal case lasts until an urgent demand arrives. This demand is fulfilled by the company at an additional cost. As the processing of the basic demands has started - picking route has already been generated - so this urgent demand has to be processed based on a separate process. Due to the urgent demand, it is necessary to change the routing plan, which depends on the amount and nature of the urgent demand. In our case, the demands could be met by the same deadline as in the ideal case, the parcels will be handed over to the courier service at 7 pm.



T1	Deadline for receipt of basic demands
T2	Deadline for receipt of late orders
T3	Deadline for the routing task
T4	Urgent demand receipt
T5	Urgent demand processing
T6	Routing plan update
T7	Deadline for demand processing
T8	The parcel was delivered

Figure-3 The effect of urgent demand on the ideal operation in the 1. case

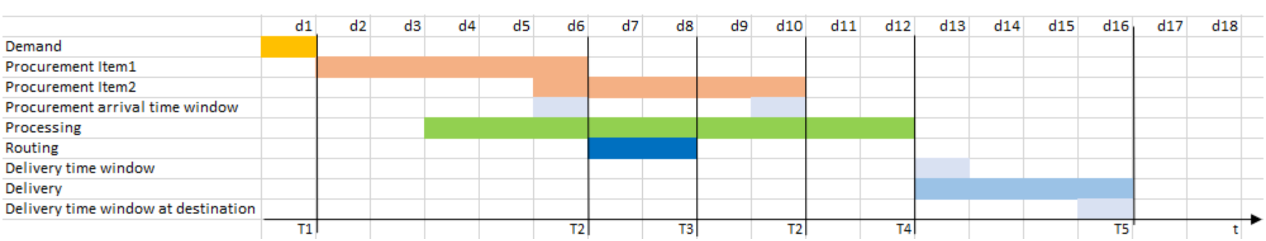
2.2.Multi-day lead time and time gates

This case shows the operation of a distribution warehouse. The warehouse can serve the demands from stock, but in some cases procurement is necessary. Incoming demands are handled and served together, and unit load is being prepared. The process may take several days to delivery.

Ideally upon receipt of demands, it will be reviewed which products are in stock and what should be procured. Procurement begins at the same time with the picking, and processing of products in stock also begins. The collected goods are waiting in the buffer area for incoming items. At the same time with the procurement process the routing can be planned how and when it is necessary to deliver / fulfill the demands.

There is a time window for the receipt of the ordered products, so the procuring process must be adjusted accordingly. A time window is also available during delivery. This is an important information for the supplier as to when they can take over the prepared orders for delivery. Demands must be processed no later than the arrival of the means of delivery i.e., the loading time window.

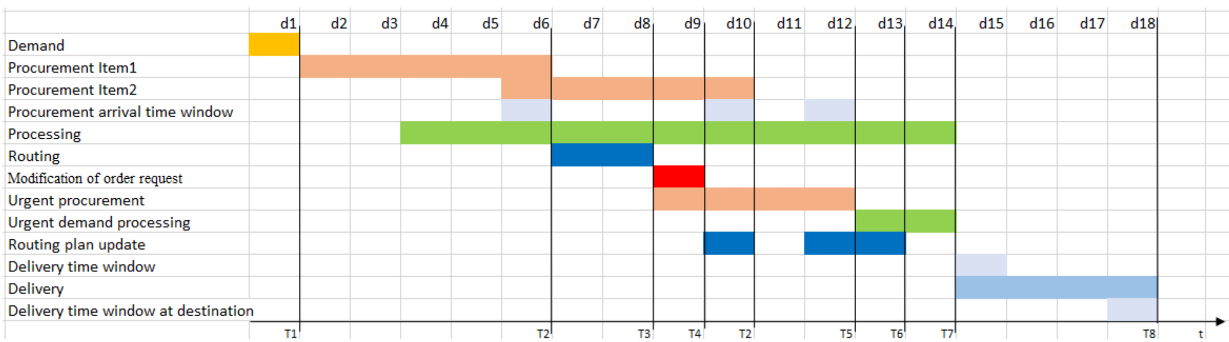
The Figure-4 shows 1 planning task and 1 delivery. Procurement received at different times will be shipped together.



T1 Deadline for receipt of basic demands
T2 Arrive of procurement for demand service
T3 Deadline for the routing task
T4 Deadline for demand processing
T5 Delivery completed

Figure-4 Ideal operation in 2. case

It happens that the customer changes the demands. It deviates from ideal operation and represents reality. Procurement has started based on previous demands, and in some cases, it has already taken into stock in the warehouse. Due to the changed demand, it is again necessary the procurement from another product. Such changes can be processed by the warehouse at an additional cost, as it generates extra work on both the procuring and processing sides. Due to the modified demand, it is also necessary to update the routing plan. In this case after the modification the company notifies the carrier partner that it will need the delivery service later, so it cancels the pre-ordered vehicle. The company can register the modified delivery date later because it is necessary to adapt to the procurement process of the modified demand. The risk of the case may be that the customer does not even need the pre-ordered product, so the procured product remains in the warehouse, or they need more / less of the given product.



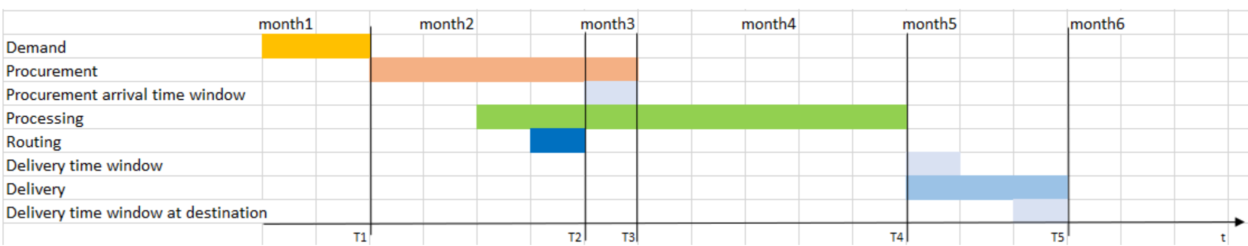
T1 Deadline for receipt of basic demands
T2 Arrive of procurement for demand service
T3 Deadline for the routing task
T4 Modification of order request
T5 Fulfillment of urgent procurement
T6 Routing plan update
T7 Deadline for basic and modified demand processing
T8 Delivery completed

Figure -5- The effect of demand change on the ideal operation in the 2. case

2.3. Long lead times and time gates for procurement arrival and delivery

This case allows for long lead times, incoming demands must be met later. The process under study is true for a construction company. The ideal operation is just the procurement, assembly, delivery.

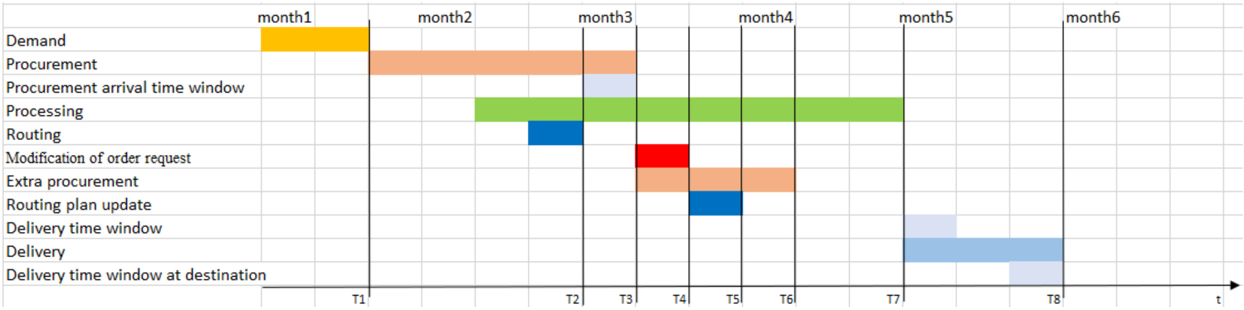
Based on the process, demands arrive in the first month. This can be done by sending the demands at once or in several installments. The company summarizes the demands, examine what needs to be ordered for performance and what they can serve from stock. Based on the existing stock, the production process starts in the second month, and after procurement, production takes place continuously. The products are delivered by railway, so the wagon have to be ordered on time. This is why the routing takes place earlier. Based on demands, it can be calculated how many wagons are needed. Due to the rail delivery, delivery can take several days or weeks.



T1 Deadline for receipt of basic demands
T2 Arrive of procurement for demand service
T3 Deadline for the routing task
T4 Deadline for demand processing
T5 Delivery completed

Figure - 6- Ideal operation in 3. case

Compared to the ideal operation, the customer may need a larger volume than they submitted their request first, or they would need another product. Because of this, the company may need extra procurement, which will incur additional costs. The routing plan needs to be modified, but due to the production volume, the pre-determined loading / delivery date can be maintained.



T1	Deadline for receipt of basic demands
T2	Deadline for the routing task
T3	Arrive of procurement for demand service
T4	Modification of order request
T5	Routing plan update
T6	Fulfillment of urgent procurement
T7	Deadline for basic and modified demand processing
T8	Delivery completed

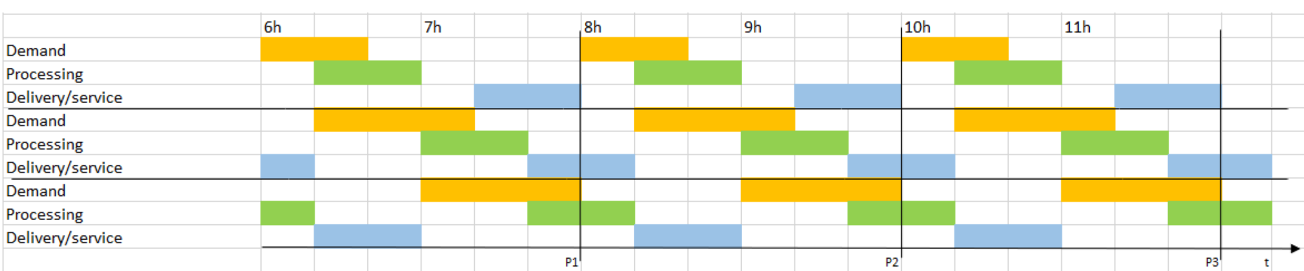
Figure-7- The effect of extra procurement on the ideal operation in the 3. case

2.4. Production service with a specific area service schedule; different by area

This case illustrates the service of production service at a specific time. The process under study is true for an automotive supplier.

There are several production areas in the factory and the production areas are serviced periodically. The supply of distribution as well as the warehouse processing of demand. In the ideal case it works according to schedule, without interruption.

The 8. figure shows the ideal operation.

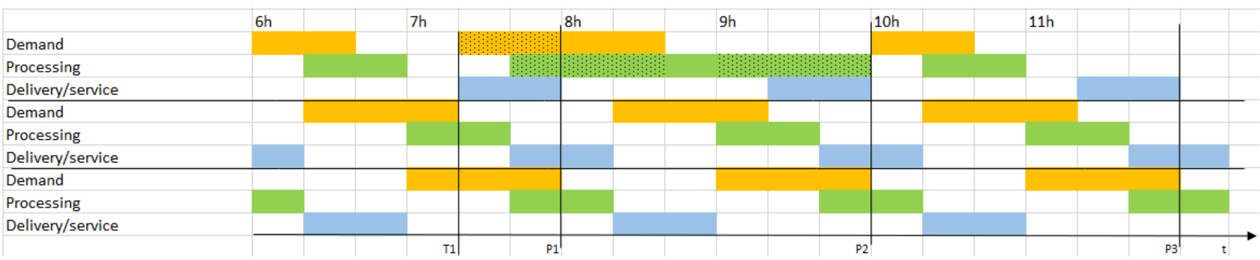


P Material supply period

Figure -8- Ideal operation in 4. case

During the day-to-day operation, the production plan may change, another product must be manufactured on the given production line. In this case, the production line can be changed by keeping the delivery / service period, but notifying the plan change in time the production line can be switched with extra processing time. Unnecessary materials can be taken back from the production line in the delivery / service period. Managing these materials is an extra job for the warehouse.

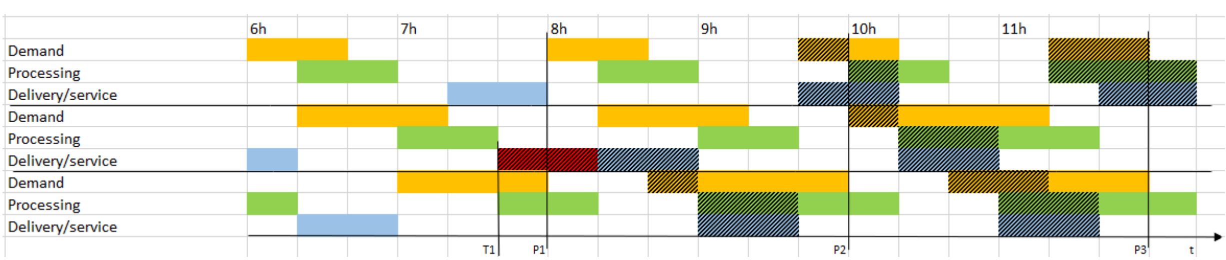
On the 9. figure we can see that the first production line had a plan modification, so the demands arrived earlier, and the warehouse had more job for processing the new demands and handling the unnecessary materials which came back from the line. After this period between T1 and P2 production continued on schedule. This is also an ideal case but there have been modifications and other types of demands that need to be handled.



P Material supply period
T1 Modification of production plan

Figure-9- The effect of plan modification on a part of the operation

On the 10. figure we would like to represent what happens if the delivery vehicle goes bad and cannot complete the task. On the second production line at the end of first period we see that the service failed at scheduled time due to an error. Delivery was made after reparation, but this problem changed the periods for each area. Changes are marked with a hatch. Due to delays in deliveries, there are earlier demands for the warehouse in addition to the usual. Due to earlier and more demand, the warehouse processing time, and the quantity to be delivered will increase, but within a few periods the scheduled service and stock quantity will be restored. Restorations of periods also depends on adaptability.



P	Material supply period
T1	Problem with the delivery vehicle

Figure-10- The effect of a technical failure on the entire operation

Without wishing to be exhaustive, these cases illustrated the demand management processes in various logistics operations. It is clear what problems may arise outside of ideal operation and what needs to be solved and adapted. In the next section, we examine the risks.

3. Risk analysis of demand services

In confirm of the topic of our study, we performed a risk analysis for the above-mentioned cases, examining what risks certain may include. Based on the literature review there were no examples of risk analysis for the processes we examined within the topic of logistics, so the topicality of the topic is given by the fact that this study fills a gap in the topic.

First of all, we identified the potential risks. During the examination general errors were identified which cover the cases examined in this article, but which can also be used for risk analysis of other logistics processes with minimal modifications. The potential risks are:

- Poor time management: too large volume; high volume late orders; deviation from processes
- Human mistake: to undertake to fulfillment an urgent demand, but it will not be realized; improperly planned routing; improperly selected means of transport; deviation from processes
- Technical error: to undertake to fulfillment an urgent demand, but it will not be realized; improperly selected means of transport
- Poorly assessed stockpiling task: too large volume orders, no stock
- Poor human management: the need for labor to perform urgent demands
- System-independent external factor: carrier is unable to meet the promised deadline for some reason

After determining the risks, we examined with matrices and performed a general analysis of the processes. Leopold matrices were used for risk analysis. This method is suitable for examining individual activities separately and their interaction with each other, that is, also for impact analysis. The rows of the matrix show each activity, which occurs in each case because we are talking about a process. However, these activities can have different effects and outcomes. The columns indicate each problem area or other condition that may affect the activity. One of the advantages of the matrices is that the columns and rows of the matrix can be summarized separately, so the critical activities and problems can be explored, in contrast, the evaluation is subjective during the method [4].

The risk analysis was divided into two groups. The first group includes cases 1, 2, and 3 which cover demand services from a classic warehouse with packaging, stacking and delivery. The second group included case 4, which represents the production service. As a result, it was not possible or worthwhile to simplify and generalize the analysis to such an extent that it would cover all cases because it would not give a true picture.

The identified risks were assigned to the demand service process. First, we examined the severity of the consequences then, in another matrix, we considered the probability of the risks occurring. For both matrices, the evaluation was performed on a scale of 1 to 5. The severity of the consequences, the extent of their effect based on the scale used in the matrix: 1 – very small, 2 – small, 3 – medium, 4 – high, 5 – very high. This is the impact analysis. The probability of occurrence was assessed on a similar scale. The scale used in the matrix is as follows: 1 – rare, 2 – not likely, 3 – moderately likely, 4 – likely, 5 – almost certain.

After the impact analysis and the determination of the probability of occurrence of the risks, the product of the two tables gives the risk values. A Leopold matrix was also used to display the risk values. With the help of an acceptability range, we can examine the risk values and decide on the acceptability of the risk. Acceptance levels were also assigned to the values, which were marked in the matrix with the color of that level: green - low, yellow - medium, red - high. The 11. figure below shows the acceptance thresholds we have set.

Acceptance Range						
The severity of the effect	very high	5	10	15	20	25
	high	4	8	12	16	20
	medium	3	6	9	12	15
	small	2	4	6	8	10
	very small	1	2	3	4	5
		rare	not likely	moderately likely	likely	almost certain
		Probability of the occurrence				

Figure-11- Acceptance thresholds

The risk analysis and risk assessment for the two groups was as follows in our study.

3.1. Cases 1, 2, 3 – warehousing and delivery services

The severity of the consequences								
	ACTIVITIES \ RISKS	Poor time management	Human mistake	Technical error	Poorly assessed stockpiling task	Poor human management	System-independent external factor	**Amount**
1.	Arrival of demands	1	2	5	4	1	5	**18**
2.	Procurement	3	1	4	4	1	4	**17**
3.	Demands processing	2	4	5	1	3	5	**20**
4.	Urgent demands, modification	3	1	4	4	3	4	**19**
5.	Extra procurement	2	1	5	3	1	5	**17**
6.	Extra demands processing	2	2	5	1	3	5	**18**
7.	Routing	3	3	4	1	1	5	**17**
8.	Delivery	1	1	4	1	1	5	**13**
	Amount	**17**	**15**	**36**	**19**	**14**	**38**	

Figure-12- The severity of the consequences in 1. group

Probability of the occurrence								
	ACTIVITIES \ RISKS	Poor time management	Human mistake	Technical error	Poorly assessed stockpiling task	Poor human management	System-independent external factor	**Amount**
1.	Arrival of demands	1	2	2	3	1	2	**11**
2.	Procurement	2	1	2	3	1	3	**12**
3.	Demands processing	2	2	3	1	2	3	**13**
4.	Urgent demands, modification	2	1	2	2	2	2	**11**
5.	Extra procurement	2	1	2	2	1	3	**11**
6.	Extra demands processing	1	2	2	1	2	2	**10**
7.	Routing	2	1	3	1	1	3	**11**
8.	Delivery	1	1	2	1	1	5	**11**
	Amount	**13**	**11**	**18**	**14**	**11**	**23**	

Figure-13- Probability of the occurrence in the 1. group

Based on the scores, the value of the risks was as follows.

Risk								
ACTIVITIES \ RISKS		Poor time management	Human mistake	Technical error	Poorly assessed stockpiling task	Poor human management	System-independent external factor	**Amount**
1.	Arrival of demands	1	4	10	12	1	10	**38**
2.	Procurement	6	1	8	12	1	12	**40**
3.	Demands processing	4	8	15	1	6	15	**49**
4.	Urgent demands, modification	6	1	8	8	6	8	**37**
5.	Extra procurement	4	1	10	6	1	15	**37**
6.	Extra demands processing	2	4	10	1	6	10	**33**
7.	Routing	6	3	12	1	1	15	**38**
8.	Delivery	1	1	8	1	1	25	**37**
Amount		**30**	**23**	**81**	**42**	**23**	**110**	

Figure-14- The value of the risks in the 1. group

3.2. Case 4 – production services

The severity of the consequences								
ACTIVITIES \ RISKS		Poor time management	Human mistake	Technical error	Poorly assessed stockpiling task	Poor human management	System-independent external factor	**Amount**
1.	Arrival of demands	1	2	4	4	1	3	**15**
2.	Procurement	3	1	5	2	1	4	**16**
3.	Demands processing	5	4	4	1	2	1	**17**
4.	Urgent demands, modification	2	1	3	3	3	3	**15**
5.	Extra procurement	2	1	4	3	1	2	**13**
6.	Extra demands processing	2	2	4	1	3	1	**13**
7.	Routing	3	3	5	1	1	4	**17**
8.	Delivery	3	3	5	1	3	5	**20**
Amount		**21**	**17**	**34**	**16**	**15**	**23**	

Figure-15- The severity of the consequences in the 2. group

Probability of the occurrence								
ACTIVITIES \ RISKS		Poor time management	Human mistake	Technical error	Poorly assessed stockpiling task	Poor human management	System-independent external factor	Amount
1.	Arrival of demands	1	2	3	3	1	1	**11**
2.	Procurement	2	1	2	1	1	2	**9**
3.	Demands processing	2	2	3	1	1	1	**10**
4.	Urgent demands, modification	2	1	1	2	2	2	**10**
5.	Extra procurement	2	1	2	2	1	2	**10**
6.	Extra demands processing	1	2	2	1	2	1	**9**
7.	Routing	2	2	2	1	1	1	**9**
8.	Delivery	2	2	4	1	2	2	**13**
Amount		**14**	**13**	**19**	**12**	**11**	**12**	

Figure-16- Probability of the occurrence in the 2. group

Based on the scores, the value of the risks was as follows.

Risk								
ACTIVITIES \ RISKS		Poor time management	Human mistake	Technical error	Poorly assessed stockpiling task	Poor human management	System-independent external factor	Amount
1.	Arrival of demands	1	4	12	12	1	3	**33**
2.	Procurement	6	1	10	2	1	8	**28**
3.	Demands processing	10	8	12	1	2	1	**34**
4.	Urgent demands, modification	4	1	3	6	6	6	**26**
5.	Extra procurement	4	1	8	6	1	4	**24**
6.	Extra demands processing	2	4	8	1	6	1	**22**
7.	Routing	6	6	10	1	1	4	**28**
8.	Delivery	6	6	20	1	6	10	**49**
Amount		**39**	**31**	**83**	**30**	**24**	**37**	

Figure-17- The value of the risks in the 2. group

4. On-demand operation possibilities

Most of the time the products are not homogenized, the product portfolios are wide and often changing, the customer demands are fluctuating and has a decreasing predictability, furthermore the production processes are strongly related to each other. Our discussed case studies highlighted several cases when adaptation to the changing environment is crucial to keep the deadlines and keep up the effective operations. Late or modified orders and the changing environment (technical failures, lack of stock, …) make the adaptive operations necessary nowadays. However, the demand is given for the more flexible operations there is a lack of adaptive intra-logistics operations systems. Most of the systems works on the previously define processes, algorithms, and policies, but different circumstances require different operations.

Our ongoing research is focusing on defining demand driven logistics processes and operations to support the right solutions in different circumstances. The basics is to realize the changed environment real-time and highlight on a predictive way, that the actually used processes and systems parameters will cause losses. Then the algorithms should offer and change for the right processes to keep up the effective operations. Process changes can be different routing methods in the warehouse, batching vs direct picking of orders, 1 or 2 step material handling, single or dual material handling commands. Further possibility is to change system parameters on-demand, like position allocation for material handling circles or storage location assignment of order picking positions.

Naturally these solutions should be used where the risk analysis highlight the necessity of the flexibility and it can reach increased effectiveness and profit.

5. Conclusion

The aim of this paper was to highlight possible use cases about the actual challenges of logistics systems. The paper presented risk analysis concept for warehousing, delivery and production services, what can highlight the necessity of on-demand operation control.

The paper highlighted the ongoing research concept how it would be possible to support operation in real time, when the circumstances changed.

We have to highlight that the IT technology is more than reachable to make the logistics operations flexible, and work based on the actual circumstances.

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