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EXPLORING THE RELATIONSHIPS BETWEEN DEMAND ATTITUDES AND THE SUPPLY AMOUNT IN CONSUMER-DRIVEN SUPPLY CHAIN FOR FMCG

Andrii Galkin
O. M. Beketov National University of Urban Economy in Kharkiv, Department of Transport Systems and Logistics, Bazhanova str. 17, 61001 Kharkiv, Ukraine, andriy.galkin@kname.edu.ua (corresponding author)
Iryna Yemchenko
Lviv University of Trade and Economics, Department of Commodity Science, Customs Affairs and Quality Management, Tugan-Baranovsky str. 10, 79005, Lviv, Ukraine, irina_vladi@ukr.net
Svitlana Lysa
Kyiv National Linguistic University, Department Management and Marketing, Velyka Vasylkivska str. 73, 03680, Kyiv, Ukraine, p-svitlana@ukr.net
Mykhailo Tarasiuk
Kyiv National Linguistik University, Department Management and Marketing, Velyka Vasylkivska str. 73, 03680, Kyiv, Ukraine, mihailotarasiuk@gmail.com
Yulija Chortok
Sumy State University, Sumy, Ukraine, Department of Economics, Entrepreneurship and Business Administration, ul. Rymskiy-Korsakova 2, 40007, Sumy, Ukraine, y.chortok@econ.sumdu.edu.ua
Yuliia Khvesyk
Taras Shevchenko National University of Kyiv, Department of Economic and Social Geography, Glushkova ave. 2, 01033 Kyiv, Ukraine, invest2606@gmail.com

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Abstract: The development of the retail market in Ukraine and in the world requires the improvement of methods and models of effective interaction of supply and demand in the supply chain for the purchase of goods of daily demand. The article presents an integrated method for demand driven supply chain management at the distribution stage for FMCG (Fast moving consumer goods). The influence of end-consumers and demand on the functioning of the logistics system has been investigated. The approach is based on systems analysis, which shows the interdependence of the parameters of the logistics system and the consumption system. The approach takes into account the parameters of consumers and the logistics system and is an extension of knowledge on the use of consumer-oriented approach in the logistics system (demand-driven supply chain). The obtained results can be used in planning and organizing a modern demand driven supply chain.

1 Introduction

Over the last 5 years, the total number of grocery stores in Ukraine has decreased by 46.8%. At the same time, there is an increase in the number of modern retail outlets by 86% [1]. Thus, currently the most common in Ukraine are such large retail chains as «Auchan», «Silpo», «Trash!», «Fozzy», «Metro Cash and Carry», «Furshet», «Velika Kishenia», «ATB», «Eco-market», «Chudo-market» and others. This contributed to the significant development of competition within the market, the struggle for customers and the improvement of marketing methods [2].

In connection with the ongoing shifts in the structure of the population, it is important to take into account the level of economic activity, employment and unemployment, which affect the nature of purchases, the opening hours of retailers, their location, transport accessibility and other factors [3]. The study of these factors allows us to solve the issues of targeting the services offered, maximizing the use of limited resources of households, considering objective criteria that make it possible to make a choice between various alternatives [4]. It is obvious that a wide variety of households and significant differences in their way of life, traditions and living standards in individual regions require a differentiated approach to managing the distribution system.

As a result, changes in consumer behavior become the most influential factor in supply chains changes. New challenges for companies participating in the supply chain in modern conditions:

- customers do not want to wait - it is known that the level of tolerance of consumers in the supply chain to nonconformities is decreasing. If 10 years ago the buyer could transfer 1% of deviations in the received order, then 5 years ago this figure was already 0.5%, and today it is about 0.1% of inconsistencies. In modern supply chains, the level of tolerance for deviations, errors or defects is generally unacceptable.

- product lines have expanded significantly - the range of products is constantly increasing.
- long delivery times for raw materials and components
- more and more goods are ordered from China, the geographical factor causes an increase in delivery times by 2-3 months.
- shortening the life cycles of goods - goods quickly become obsolete, for example, the life cycle of a phone is 1 year, while components can be delivered for six months.
- inaccurate forecasts - forecast algorithms are based on historical information and the longer the planning horizon and detail, the less accurate the forecast.
- low inventory targets - the company must keep stocks low to minimize costs, but at the same time, stocks must match demand and not become "illiquid".

The variability of the situation in any market, seasonality, make the analysis of the distribution of goods among end-consumers necessary and compelled for the effective functioning of any supply chain [5]. In such conditions, improving the efficiency of logistics systems based on the preferences of end-consumers is a necessary component of the transition to the concept of Industry 4.0 [6]. Awareness of the significant role of the final consumer (person) in the distribution of goods requires constant and systematic analysis of its impact on the demand driven supply chain. Consideration of Consumer-driven logistics systems theory allows to revise modern concepts and expand them with new knowledge. The aim of the paper is to establish demand driven supply chain for FMCG and exploring relationships between demand attitudes and the supply amount in it. The article consists of the following sections:

- Introduction, which describes the relevance and feasibility of the study;
- Analysis of the literature, which describes modern methods of interaction of FMCG market participants, analyzes the relationship between logistics and marketing, and logistical approaches to demand and logistics systems, methods of demand distribution in the service area.
- Research methodology, which describes the main provisions of the proposed method. The proposed theory is considered in a case study. Patterns of Supply-Demand interaction in the supply chain for the purchase of FMCG are identified. The influence of the number of inhabitants, individual consumption, average time of movement to the store on EOQ are established.
- The last section presents the conclusions of the article.

2 Reference review

Over the past decade, there has been a clear shift in the manufacturer's attention towards end-consumers. Analysis of the theoretical and practical works [7] in the field of logistics and its applied implementation allows us to conclude that in recent years, approaches to the study of industry characteristics of the distribution of finished products have been updated. Simultaneously, the existing theoretical and methodological apparatus used in the management of cargo distribution does not allow to effectively address the identified challenges for FMCG, which necessitated the development of the current conceptual framework in this article.

FMCG is the most popular product in the public economy. Their volume, the number of items grows every year [8], the share of marketing and sales costs increases to expand their market share and make a profit. This article aims to study the interaction of supply and demand at FMCG, which will establish the impact of end-consumers behavior on logistics decisions in the supply chain, namely Economic Order Quantity (EOQ). This will enrich modern methods of managing the distribution of FMCG products on end-consumer behavior.

The successful development of the demand driven supply chain in the FMCG sector is facilitated by the automation of demand forecasting, planning sales, supplies, production, purchases, which has now become possible due to the use of a single tool – the SCM system [9]. SCM systems are supply chain management systems that should cover material flow management from forecasting sales to purchasing raw materials (for a manufacturer) or ordering a supplier (for a distributor). Modern demand centric SCM-system includes: Demand Forecasting, which takes into account the analysis of the influence of TMA and external factors [10]; Sales Planning [11]; Distribution Requirements Planning [12]; Advanced Planning & Scheduling [13]; Material Requirements Planning [14].

This path involves many processes (warehouse logistics, production, replenishment and sales planning, distribution by DC, planning trade marketing activities, etc.) that require careful planning, which allows to implement a set of SCM tools implemented in a demand driven supply chain.

In any supply chain, a plan for sales, production, procurement is developed. At the same time, there are few places where these plans can be rigidly linked to each other, and for the most part they are even developed «in different coordinate systems». For example, a production plan for a product can be planned in pieces or tons, a sales plan in euros or dollars, and a shipping plan in wagons or containers. Thus, it is very difficult to understand how many pieces of products needs to be produced in order for the company to fulfil the sales plan, or how many wagons and containers will need to be shipped to transport all manufactured. This is due to the fact that different divisions of the company solve different problems, and it is more convenient for each of them to look at the business from their own point of view. At the same time, close interaction between departments and the constant exchange of data between them is often not a priority in companies. In addition, FMCG require adjustments due to the specifics of their activities or market conditions. In different supply chains, depending on the type of business, specific problems can vary greatly, but the general tendency of data fragmentation in different links of the chain and a lack of information exchange between them is very often observed. The most successful global companies have long gone from disparate planning to integrated planning, and for this, in particular, the concept of Logistics 4.0 and demand driven supply chain was developed [15]. Research of technologies of logistic management of urban freight flows allows to reveal sequence and approaches to management of technological stages of their advancement. The main directions of improving the efficiency of material flow distribution were identified, but, at the same time, it was found that scientific concept solve the problems of certain aspects of logistics, but do not fully considered the most important aspects of contemporary logistics - the end-consumer [16].

The analysis of the literature indicates that insufficient attention is paid to the issues of material flow management in logistics systems, especially at the stage of distribution among end – consumers [17]. So, in works [18, 19] the following types of logistic activities are considered: customer service [20]; demand forecasting; inventory management (warehousing, freight processing, packaging, etc.) [21]; selection of locations for facilities (warehouses, distribution centers, production facilities, etc.) [22]; reverse flows administration [23]; management of production processes [24]; fleet management [25] and more. In fact, Patterns of Supply-Demand interaction in the supply chain for the purchase of FMCG requires further consideration, especially in contemporary pandemic circumstances [26].

Recent studies stress significant attention on the influence of end-consumers on generating and distribution of FMCG, especially in cities. General approaches, macro- and micro- models of logistics management have been developed [27]. Most research focuses on demand modeling rather than on the supply-demand interaction methods. Customer-Driven Supply Chain is a new concept, which has evolved from the supply chain management research stream [28]. This approach leads to rethinking Supply Chain Management [29]. A new orientation in Supply Chain Management constantly leads to growing freight demand and transportation. In recent years, freight traffic has become an important factor in the development of countries. According to statistics, the efficiency of freight transportation is associated with an increase in gross domestic product (GDP) [30]. Thus, based on modelling and conducted an empirical analysis of freight traffic, the distance between supplier and place of production and prices for transport services during time-windows in India established influence urban regulation rules on the cost [31]. Prof. Kulshreshtha M. and Prof. Nag V. also used cointegration models «VAR» in modeling the demand for Indian rail freight [32]. More detail the demand for freight in Rome and other Italian cities using six econometric models [33]: traditional regression model (OLS), partial adjustment model (PA), reduced autoregression model with distributed delay (ReADLM), vector autoregression (VAR) model, time-varying parameter (TVP) model and structural time series model. Urbanization, increasing level of motorization, changing consumer behavior due to the spread of smart and green lifestyles, the adoption of new philosophies of production (such as Logistics 4.0) and many other factors have led to the emergence of new mechanisms of interaction in urban transport systems [34].

The references review allows to draw a conclusion that in recent years approaches concerning studying of branch features of distribution of FMCG are actualized. At the same time, the existing theoretical and methodological apparatus used in the management of the distribution of freight flows, does not allow to effectively address these challenges, which necessitated the exploring the relationships between demand attributes and the supply amount in consumer-driven supply chain set out in this paper.

3 Conceptual framework

3.1 Formalization of the Supply-Demand interaction model in consumer-driven supply chain

Designing a consumer-driven supply chain is reduced to an end-to-end forecast of demand and sales markets, as well as the determination of the main planned characteristics of supplies that meet the needs of each zone of end consumers, Figure 1.

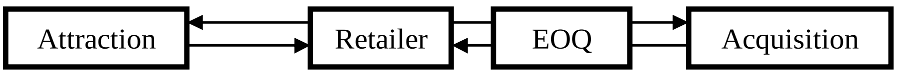


Figure 1 Interaction of Attraction and Acquisition

The frequency and size of purchases allow us to determine the assortment, volumes, packaging of goods, calculate the required stock, the rhythm of product supply, identify the main points of sale, the location of retail trade enterprises. Therefore, the «Acquisition» submodel, on the other hand, deals with determining the strategy for placing stocks and orders, the optimal delivery lot (EOQ) of different commodity items, the necessary logistics infrastructure for the optimal concentration of stocks in the distribution system.

It is advisable to formalize Patterns of Supply-Demand interaction in consumer-driven supply chain for the purchase of FMCG taking into account the elements of the system (subsystems) involved in the promotion of material flows in the form of:

$$C \in \langle \{x, y, z\}; S^{x,y,z} \rangle, \quad (1)$$

where C – consumer-driven supply chain; x – «Acquisition» subsystem; y – «Retailer» subsystem; z – «Attraction» subsystem; $S^{x,y,z}$ – subsystem's links.

Connections $S^{x,y,z}$ depending on their nature can be informational, technical, organizational, technological, commercial and legal, etc.

Subsystem "Acquisition", in turn, has the following form:

$$x \in [\{x_1\} \cup \{x_2\} \cup \{x_3\}], \quad (2)$$

where x_1 – many logistics operators; x_2 – set of goods; x_3 – many technologies for the supply of goods.

Consists of subsets that detail the technology of operation of individual entities for the sale of goods in the form:

$$y \in [\{y_1\} \cup \{y_2\} \cup \{y_3\} \cup \{y_4\}], \quad (3)$$

where y_1 – many retailers in the market; y_2 – many technologies for the sale of goods; y_3 – many technologies for placing and processing orders; y_4 – range of goods.

Subsystem z combines elements related to «Attraction»:

$$z \in [\{z_1\} \cup \{z_2\} \cup \{z_3\} \cup \{z_4\}], \quad (4)$$

where z_1 – many end users; z_2 – set of goods; z_3 – many technologies for purchasing goods; z_4 – many types of travel.

In turn, each of the elements of the subsystems can be detailed with elements of the next level. Thus, each subsystem can be considered as an independent system. The development and improvement of each structural element of the consumer-driven supply chain is aimed at improving the efficiency of the entire system. Conversely, a failure in any of the subsystems, or at the level of the elements and their connections, leads to the failure of the system as a whole. The global demand-driven supply chain should not provide for the integration of all its elements under a single governing body, but should provide for a reasonable coordination of their functions on the basis of mutually beneficial cooperation.

3.2 The management cycle in a demand-driven supply chain

Demand-Driven Inventory Management — a methodology that is used for both planning and follow-up, by determining (1) where to store inventory and (2) and how much to keep (3), dynamically (4) generate purchase orders based on average daily use, taking into account the corresponding peaks in sales, and finally (5) coordinate and prevent execution in a visual way. The cyclical process of re-planning in the demand-driven supply chain can be divided into 4 phases: formation of outgoing data; identification and calculation of demand; planning of supplies; implementation, comparison and analysis of results. Each subsequent stage in the planning cycle uses the information from the previous stage, analyzes the reasons for the discrepancy between the plan and the fact, makes changes to the demand-driven supply chain management model, and repeats the process again, Figure 2.

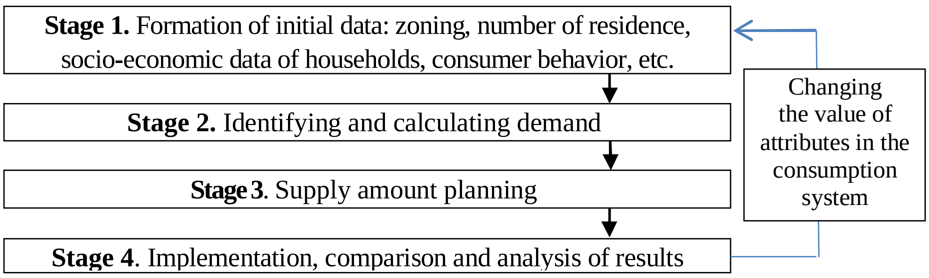


Figure 2 The circle of management in a demand-driven supply chain

3.2.1 Formation of initial data

The area of service based on earlier developed approach [35]. The retailer service zones has designed under influence on individual end-consumer behavior parameters [36], geographic characteristics of the territory [37]. Considering the influence of these parameters will allow adjusting the limits of the retailer's service area. The presented zone is the basis for gathering socio-economic data of end-consumers in the zone [38]. Taking into consideration the set of attributes (end-consumer; journey; end-consumers zones; purchase) can be established for each zone, fig. 3. The set of such attribute values forms the attractiveness of the retailer in relation to end consumers and the volume of their individual demand from the participant of retail trade.

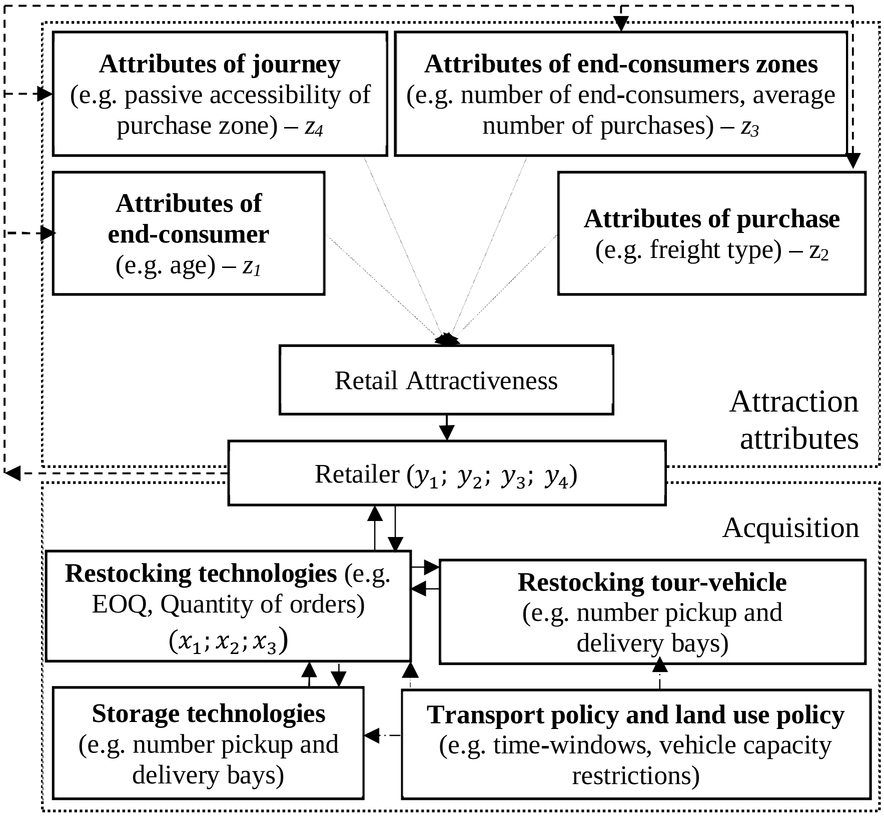


Figure 3 Methodology for planning demand-driven supply chain in urban area

– information flows (feedback between advertising, price, retailer service and attraction attributes of end-consumers);
– regulatory impact of the local transport and land use policy Restocking technologies;
– flows of goods; – shopping mobility

3.2.2 Identifying and calculating demand

Individual demand of end consumers generates their retailer sales. Retailers of different forms of ownership and organizational and legal forms have different parameters (size, service time, range, number of cash registers, etc.), which affects the flows of end users and their behavior. Generalizing all the parameters, it is possible to combine them into groups that form the volume of demand – on the one hand, and the technology of restocking – on the other: the set of retailers in the market (y_1); many technologies for the sale of goods (y_2); set of technologies for placing and processing orders (y_3); range of goods (y_4).

3.2.3 Supply planning

It is known that the demand for goods (demand) affects the EOQ value that must be supplied to the retailer. The formed Cycle of management in demand-driven supply chain, allows to define average volume of demand of the participant of a retail network taking into account parameters change of system of consumption.

The scope of delivery can be determined using the Wilson formula. When servicing a retail network, the volume of delivery will consist of the individual needs of each retailer.

3.2.4 Implementation, comparison and analysis of results

Based on the results of already completed shipments, it is possible to analyze the parameters of DDSC operation and clarify the characteristics of customers, their preferences and develop an optimal technology for their service. Conducting comparative analyses among those who have already made a purchase and those who have not. Then, based on the identified distinctive features, the profile of the client and the future offer to him are determined. When the system responds as quickly as possible to demand, estimates the lead time and "builds" them into the existing production plan, the synchronization of the rest of the supply chain is much faster, respectively, the response time increases significantly. The basic rule of business still works: the winner is the one who provides the customers with what they need with the best level of service faster.

To implement the proposed technology and study patterns, let us consider an abstract example.

4 Case simulation

4.1 Zoning

Consider an example (Figure 4). The figure shows a schematic location of four retail outlets (A, B, C, D) relative to the household.

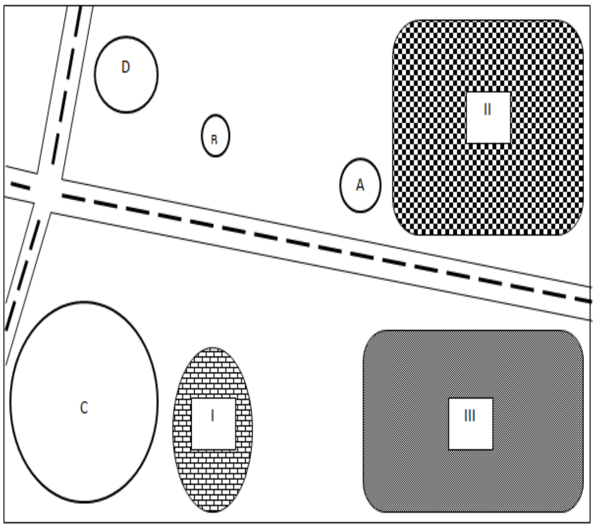


Figure 4 Zone in which there are four retail outlets and three areas of residence of consumers, depending on their number of storeys:

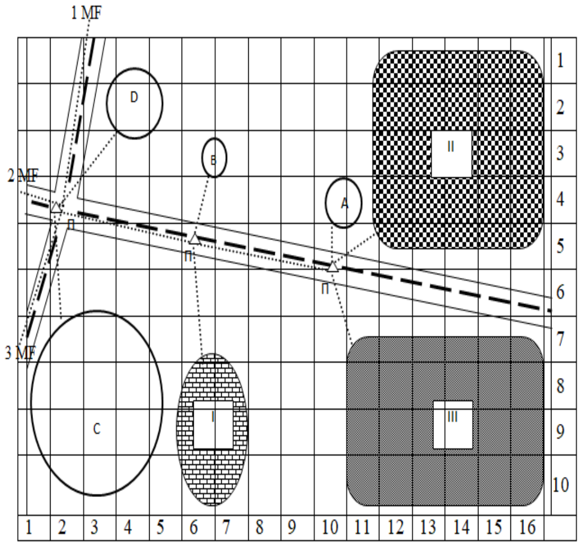


Figure 5 Construction of the transport links:

– Building area (10-12 floors); – Building area (1-2 floors); – Building area (5-7 floors);
– retailers; Π_1, Π_2, Π_3 – crossing; 1 MF, 2 MF, 3 MF – incoming material flow

Construction of the transport scheme is performed in the following sequence:

1. Fig. 4 presents the location of the participants of the shopping mobility process (retailers, places of residence of end-consumers).

2. We establish connections between related participants in the transport process. In real conditions they can be determined using Google maps [39], Figure 5.

The results of the calculations are presented in Table 1).

Table 1 The matrix of the shortest distances for transportation of freights

	A	B	C	D	I	II	III	П1	П2	П3	1 MF	2 MF	3 MF
A	-	0.58	1.24	1.21	0.72	0.22	0.27	0.94	0.48	0.07	100.94	150.94	200.94
B		-	0.86	0.83	0.34	0.66	0.71	0.56	0.1	0.51	100.56	150.56	150.56
C			-	0.57	1	1.32	1.37	0.3	0.76	1.17	100.3	150.3	200.3
D				-	0.97	1.29	1.34	0.27	0.73	1.14	100.27	150.27	200.27
I					-	0.8	0.85	0.7	0.24	0.65	100.7	150.7	200.7
II						-	0.35	1.02	0.56	0.15	101.02	151.02	201.02
III							-	1.07	0.61	0.2	101.07	151.07	201.07
П1								-	0.46	0.87	100	150	200
П2									-	0.41	100.46	150.46	200.46
П3										-	100.87	150.87	200.87
M1											-	250	300
M2												-	350
M3													-

4.2 Attraction and Acquisition system s interaction

Characteristics of retailers in the zones of residence of consumers, shown in Figure 6 are presented in Table 2 and Table 3) D. Huff's model was used to estimate the probability of visiting the retailer. The results of calculations of the probability of visiting shops (A, B, C, D) by consumers living in zones I, II, III are given in Appendix A. Thus, the calculations show the probability of visiting each of their four retail businesses by consumers living in different zones. From the Table 4, it is seen that the probability of visiting the retailer by end-consumers of different groups differs. The most probable place of purchase for the first group of consumers was retailer A (the first in size, and the closest to the consumers of this group, for the second group of consumers – retailer C (third in size, but located much closer to households than the largest shop C), for the third group – retailers C and A.

The least likely place of purchase among all consumers are retailers *B* and *D* – their share is – 13% of total sales in the zone. Different consumers have different propensities to consume different material flows. The propensity to consume the material flow depends on many factors (price, personal preference, etc.). We use a different level of consumer income, which depends on the zone of his residence, to determine the propensity to consume a certain material flow. In Table 5, the characteristics of the consumption of material flows for the month are given, depending on the level of their income.

Table 2 Characteristics of retailers

Retailer (*j*)	Retailer area (*S*), m^2	Travel time from the liviiling zone to retailesr, h		
		I	II	III
A	785,3	0,42	0,025	0,25
B	282,7	0,37	0,44	0,56
C	7068	0,05	0,71	0,62
D	2405	0,5	0,62	0,85
Total	10,5417	-		

Table 3 Characteristics of consumer areas

Building area (*ω*)	Number of floors	Area (Size) of the zone (*S*), ha	Population density depending on the number of storeys ($p_{ж}$)*, people/ha	Number of inhabitants in the area, pers.
I	10-12	21,206	140	2969
II	5-7	27,563	125	3446
III	1-3	19,5	100	1950
Total		68,269	365	8365

Table 4 Determining the distribution of consumers across different retailers according to D. Huff's model

Number of consumers in the development area, pers.	Building area (ω), %			Building area (ω), persons			Total consumers , pers.
	I	II	III	I	II	III	
	2969	3446	1950	2969	3446	1950	
Retiler	Indicator of the relative attractiveness of the retailer *j*(p_{ij})			Distribution of consumers by retailers, pers.			
A	0,16%	98,30%	35,71%	5	3387	696	4088
B	0,07%	0,11%	2,56%	2	50	50	56
C	99,4%	1,10%	52,26%	2952	38	1019	4009
D	0,34%	0,49%	9,46%	10	17	185	211
Total	100%	100%	100%	2969	3446	1950	8365

Table 5 Characteristics of consumers and their preferences for consumption

Parameter		Characteristics of consumers and their preferences for consumption		
Consumer area (ω)		I	II	III
Individual demand of a consumer who lives in a certain building area for a period of time, units	1 MF	300	200	50
	2 MF	150	250	100
	3 MF	50	150	250

In determining the flow of goods, the leading role is played by the size of purchases made by households. Social production and consumption in any state and region, taken over a relatively long period of time, is progressive and increases in scale. This requires a corresponding increase in the capacity of trade channels that ensure the movement and sale of goods in the main market of end consumers.

According to the considered zones of research and statistics on consumption it is possible to define necessary quantity of consumption for all trade zones:

$$q_m{}^n = N^n \cdot n_m , \qquad (5)$$

where N^n – the population of the n-th zone; n_m – the required amount of product *m*, kg.

The consumption of products during the year is equal to the quantity of supply. Using the classic Wilson model (EOQ) we can find the optimal order quantity and number of deliveries, Table 6.

In determining the flow of goods, the leading role is played by the size of purchases made by households. The volume of sales of material flows in retailers is presented in (Table 7).

The material flows under consideration are interchangeable. The first material flow is the cheapest, the third is the most expensive, the cost of the second is between the values of the first and third material flows. Thus, the first material flow – with high, the second – with medium.

Models of analogy approach and regression analysis leave a lot of freedom to describe the benefits, namely, to interpret *P*. The scheme does not prohibit the use as an average estimate of the distribution of costs, which should give the output of the model turnover forecasts. Often, *P* means the distribution of visits or the distribution of stores according to the criterion of maximum importance for the consumer. In the latter case, the sample is artificially limited to those households that make the bulk of purchases in this category in only one outlet. The problem of measuring benefits comes down to the problem of asking basic questions. The effectiveness of ways to describe the benefits is determined by the type of enterprise for which the study is conducted.

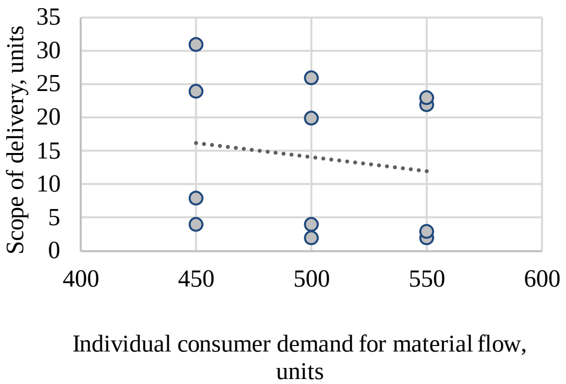
The influence of the retailer's parameters on the optimal volume of delivery and the number of deliveries is presented in Figure 6.

Table 6 Determination of the number of consumers for different retail facilities

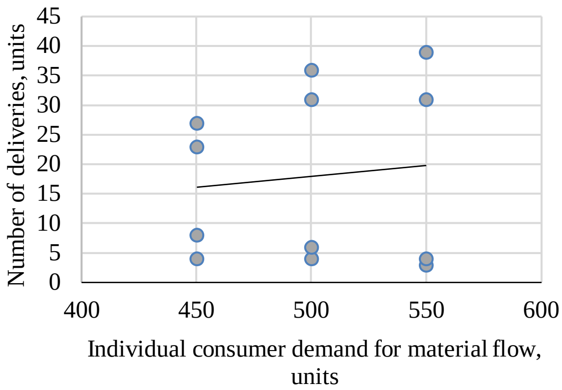
Material flow	Transportation distance, km	Time of loading and unloading, h	Weight of unit, kg	Cost per order, USD/order	Annual holding cost per unitr, USD/unitr	EOQ, units	Quantity EOQ, ton	Necessary quantity of orders, units
1 MF	100	0,94	1	316,5	0,8	23764	23,764	31
2 MF	150	0,94	1,15	421,5	1,2	25384	29,191	37
3 MF	200	0,94	1,4	709	1,6	24593	34,430	28
Total quantity for retailer A						73741	87,385	96
1 MF	100	0,56	1	278,5	0,8	1655	1,655	3
2 MF	150	0,56	1,15	383,5	1,2	2008	2,3092	4
3 MF	200	0,56	1,4	671	1,6	3326	4,6564	4
Total quantity for retailer B						6989	8,6206	11
1 MF	100	0,3	1	252,5	0,8	24414	24,414	39
2 MF	150	0,3	1,15	357,5	1,2	18172	20,897	31
3 MF	200	0,3	1,4	645	1,6	18139	25,394	23
Total quantity for retailer C						60725	70,706	93
1 MF	100	0,27	1	249,5	0,8	3121	3,121	6
2 MF	150	0,27	1,15	354,5	1,2	3780	4,347	7
3 MF	200	0,27	1,4	642	1,6	6281	8,7934	8
Total quantity for retailer D						13182	-	21

Table 7 Determination of the volume of sales of material flows for different retailers

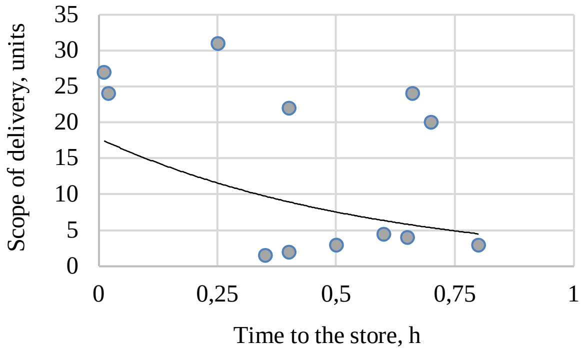
Retailer	Total consumers, pers.	Material flow	Sales volume by zones, units			Total, units
			I	II	III	
A	4088	1 MF	1394	677478	34819	713692
		2 MF	697	846848	69638	917184
		3 MF	232	508109	174096	682437
		Total A	2324	2032435	278554	2313313
B	56	1 MF	647	787	2498	3932
		2 MF	323	984	4996	6304
		3 MF	108	591	12491	13189
		Total B	1079	2363	19985	23425
C	4010	1 MF	885645	7560	50957	944163
		2 MF	442823	9451	101915	554188
		3 MF	147608	5670	254787	408065
		Total C	1476076	22682	407660	1906418
D	211	1 MF	3014	3374	9226	15613
		2 MF	1507	4218	18451	24174
		3 MF	503	2532	46127	49159
		Total D	5023	10122	73802	88947
Total	8365	Total	2969	3446	1950	4332103



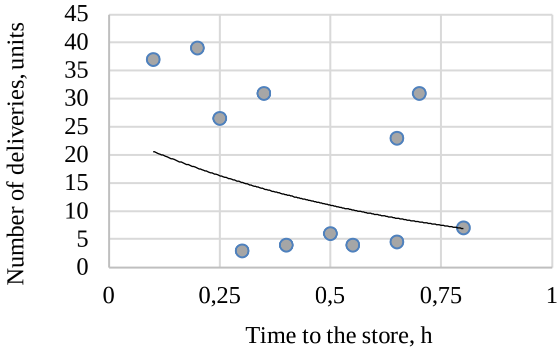
A) *Dependence of the volume of supply on individual consumer demand*



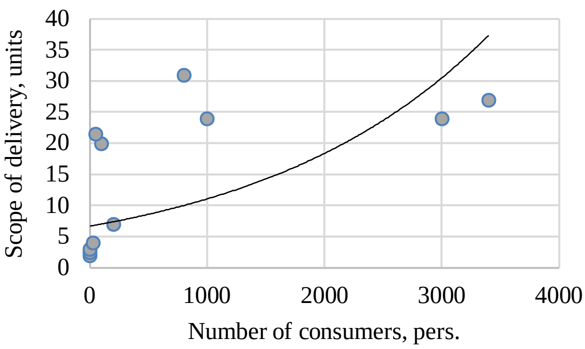
B) *Dependence of the number of deliveries on individual consumer demand*



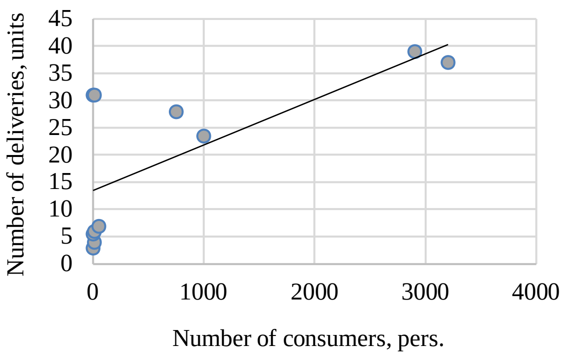
C) *Dependence of the volume of delivery on the travel time of consumers to the retailer*



D) *Dependence of the number of deliveries on the travel time of consumers to retailer*



E) Dependence of the volume of supply on the number of consumers



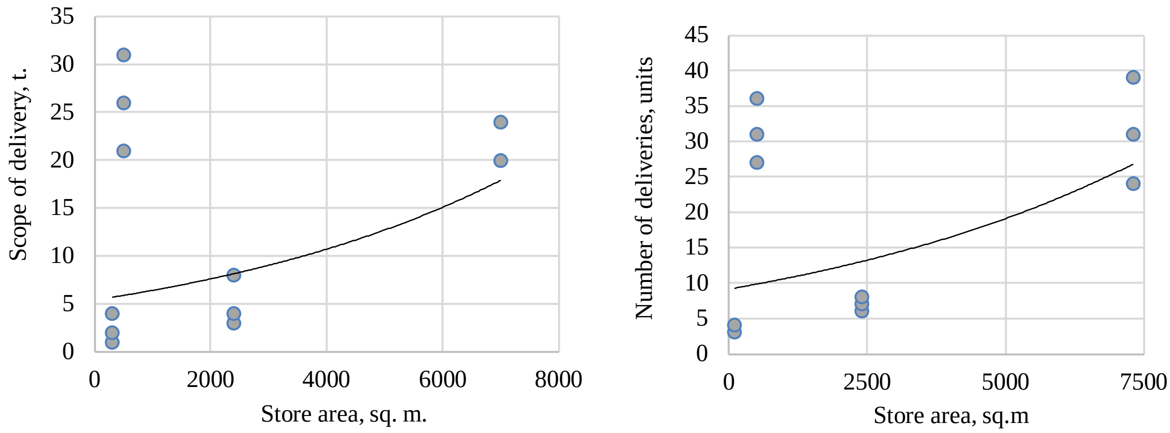
G) *Dependence of the number of deliveries on the number of consumers*

Figure 6 Dependence of delivery volume and quantity of deliveries on parameters of zones of final consumers

The dependence of the volume of supply and the number of deliveries to it on individual consumer demand (Figure 6, A and B) is described by a linear relationship. Although the closeness of the connection is quite low, but the analysis of Figure 6 shows that the increase in individual consumer demand reduces the value of EOQ and increases the number of deliveries to the store. The dependence of the volume of delivery and the number of deliveries to it from the time of travel of consumers to the store (Figure 6, C and D) are described by a parabolic function. The connection is average. Analysis of Figure 6 shows that stores that are closer to consumer areas need to be supplied with larger quantities of orders at a high frequency. Increasing the distance reduces the EOQ and the number of stores that are in the middle distance from their customers. As the distance increases further, the EOQ and the number of deliveries to the store increase. The presence of an extremum may indicate different types of stores and shopping zones that they serve: a store near the house, a supermarket, a hypermarket. Consumers try to make a lot of purchases in large hypermarkets in order to save money, small everyday purchases – on the way home from work.

The dependence of the volume of supply on the number of consumers (Figure 6, E) is described by a power dependence, and the number of deliveries to the store on the number of consumers (Fig. 6, G) – by a linear function. Analysis of Figure 6 shows that an increase in consumers increases the value of EOQ and increases the number of deliveries to the store.

Analysis of different functions of the influence of store size on EOQ and their number in the period showed that the most suitable function in both cases is a power-law function. The coefficient of determination indicates a weak relationship between the independent and dependent variable. Analysis of Figure 7 shows that an increase in store size increases the volume of the shipment to it and the number of deliveries.



E) Dependence of Scope of delivery on Store area G) *Dependence of the number of deliveries on the Store area*

Figure 7 Dependence of the scope of delivery and the number of deliveries on the parameters of retailers

Changing the value of demand and attractiveness of retailers for the end-consumer in different periods or during distribution will affect the amount of material flow in the logistics system, which can change the delivery technology. Large volumes of demand can be served by simple routes, small consignments – by delivery routes for instance. The technological process, time and cost of maintenance in such cases will be different. The effectiveness of the use of different logistics technologies in the service of different stores and consumer groups with different parameters requires further study.

5 Conclusions

The resulting model takes into account the cost of purchasing goods, the parameters associated with the movement of end-consumers to members of the retail network, the characteristics of individual members of the retail network and their competitors. The change of these parameters affects the volume of sales of retail network participants.

Using the system opens up new opportunities that many companies did not know about before. In terms of inventory, demand driven supply chain takes a compromise position between MRP and Lean. This concept does not define stock accumulation as "waste" as it does Lean, but it also does not seek to set inventory levels in a static way, as MRP usually does. Rather, the methodology seeks to keep the right amount of inventory in the right place in the supply chain "to promote flow but minimize working capital" and "dynamically adjust the size of strategically located stock" based on a set of rules.

The advantage of the method is the ability to take into account the parameters of end users and the parameters of the external environment (distance to the retailer, its size, the average level of margin). However, the results of the method are sensitive to the range of data variation. Changing the parameters of the model used in the calculations (physiological characteristics of the residents of the zones, income, structure of food costs, etc.) will lead to a change in the structure of costs and redistribution of retailers' attendance.

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