

# MODELLING BUSINESS PROCESSES BASED ON LOGISTICS CONCEPTS AND QUALITY MANAGEMENT SYSTEM PRINCIPLES

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## **ABSTRACT**

*In the article, the authors considered the theoretical and methodological foundations of modelling business processes, namely business processes of an enterprise (including business processes in logistics), modern logistics concepts, as well as the principles of a quality management system. The theoretical and methodological study made it possible to form a research methodology, conduct an experiment on the example of a transport and logistics business process, and also propose a business process model based on logistics concepts and principles of a quality management system. With minimal adaptation, this model can be used for all business processes of business entities.*

**Key words:** Business Process, Logistics Concept, Multi-Criteria Decision-Making Problem, Quality Management System Principles

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## 1. INTRODUCTION

Modelling business processes is one of the methods to improve the quality and efficiency of an organization. This method is based on the description of the process through various elements (actions, data, events, materials, etc.) inherent in the process. Typically, business process modelling describes the logical relationship of all elements of the process from its beginning to completion within the organization. In more complex situations, modelling may involve processes or systems external to the organization.

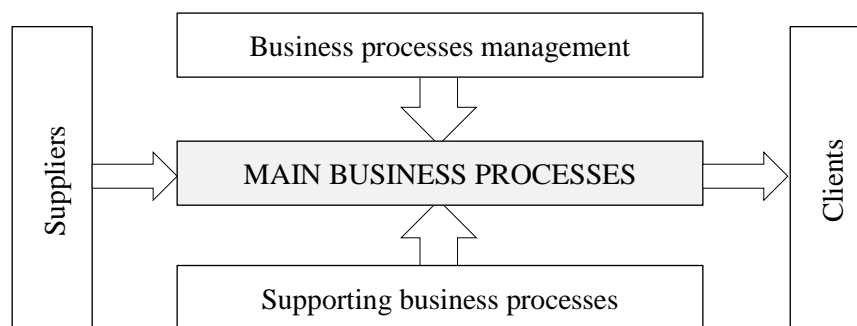
Business process modelling allows you to understand the work and analyze the organization. This is achieved since models can be drawn up for different aspects and levels of management. In large organizations, business process modelling is performed in more detail and more versatile than in small ones, which is associated with a large number of cross-functional relationships.

Typically, various computer tools and software are used to model business processes. This makes it easier to manage models, track changes in them and reduce analysis time. However, the introduction of management principles, along with specific business process concepts, can significantly improve the synergistic effect of modelling.

## 2. THEORETICAL AND METHODOLOGICAL FOUNDATIONS FOR MODELLING BUSINESS PROCESSES

### 2.1. Enterprise Business Processes

Business process (business method or business function) is a collection of related, structured activities or tasks by people or equipment in which a specific sequence produces a service or product (serves a particular business goal) for a particular customer or customers (Weske 2012; von Scheel et al. 2014; Kirchmer 2017; Lagodiienko et al. 2019; Prokopenko et al. 2020a). Business processes occur at all organizational levels and may or may not be visible to the customers. A business process can often be visualized (modelled) as a flowchart (Fig. 1) (Chen 2012; Chand and Chircu 2012; Prokopenko et al. 2020b).



**Figure 1** Enterprise business processes (authors' development based on (Chen 2012; Chand and Chircu 2012; Prokopenko et al. 2020b))

### ***Business processes in logistics***

A logistics system is a set of several business processes:

- Planning the movement of goods. Refers to the planning and management process.
- Delivery to the warehouse of products received from a supplier or manufacturer. This is part of the resource process described above.
- Inventory control. Marking and inventory is a section of the resource process.
- Transportation of products to stores. This function is included in the sales process.
- Control of commodity flows. Observation of their movement is carried out within the framework of planning and management.

In general, the following functions are assigned to the logistics service (Karyy and Podvalna 2016; Galkin et al. 2019):

- coordination of the date of receipt and the date of dispatch of consignments of products;
- making calculations for transport costs;
- drawing up maps of transport routes for the safest and fastest movement of goods;
- drawing up a plan according to which consignments of products will be delivered;
- acceptance with subsequent storage of the delivered cargo in the warehouse;
- collection of applications sent by stores;
- change in the status of a product (was - reserve, became - expedition);
- filling in the waybills (mark spacer);
- collection and analysis of information on available transport;
- selection of the optimal delivery route;
- shipment from the warehouse of the assembled and packed goods;
- informing the recipient about the time of arrival of the car with the cargo;
- continuous monitoring of the movement of goods along the route;
- accounting of products that have been returned;
- supervising the processes of returning, sending and posting goods.

Production, trade and economic systems work effectively only with the organization of the correct logistics, which guarantees the timely delivery of raw materials to factories and factories, the shipment of finished goods, their storage, accounting, transportation to the consumer at the appointed time with a minimum cost.

## **2.2. Modern Logistics Concepts**

The emergence and development of logistics concepts are closely related to the evolution of business in industrialized countries. The fundamental concepts in logistics are:

- Information
- Marketing
- Integral

*The information concept of logistics* appeared in the late 1960s and is closely related to the development of information and computer technologies.

The main idea of this concept is to formulate the general problem of managing the material flow of a business object (a firm as a whole or a separate functional area: supply,

production, sales) and at the same time synthesize information and computer support for solving the problem.

The theoretical basis of the information concept is a systematic approach used in this case, both for modelling the objects themselves, and for the synthesis of information and computer support systems. The leading solutions are to automate trivial tasks and use information and computer support to solve logistic optimization problems. At the same time, optimization of the entire material flow management process, as a rule, is not a goal within this concept. Practical examples of using the logistics information concept are the general information and software modules MRP I, MRP II, DRP, OPT, QR, CR, etc. used in the automation of in-house planning and inventory management and procurement of material resources, as well as the production and supply of finished products to consumers.

At the same time, logistics systems, originally built solely on the principles of the information technology concept, did not have the necessary flexibility and integration, which are required at the present stage of the development of a market economy, for example, to regulate relations between producers and suppliers and end consumers of products.

From the early 1980s to the present, the marketing concept is often used in the construction of corporate logistics systems. *The marketing concept of logistics* focuses on the attention of the company's management on organizing the logistics process in the field of distribution (distribution) to strengthen the organization's position in the competition. Such a logistics system should support the organization's competitive market strategy by making optimal distribution decisions, forecasting demand for products, integrating logistics operations and physical distribution functions.

In recent years, a new logistics concept has been actively spreading, which most researchers call integral or the concept of integrated logistics. This concept, in essence, develops marketing, taking into account the new business conditions at the present stage:

1. Further understanding of market mechanisms and logistics as a strategic element in the competitive capabilities of the firm.
2. New organizational (structural) relations, prospects for integration between logistics partners.
3. New technological opportunities, in particular, in the field of flexible production and information and computer technologies, control and management in all areas of production and distribution of products.

The complication of market relations and increased competition are currently leading to the transformation of the logistics system, which is expressed in the following main trends:

1. The speed, intensity and complexity of material and information flows are increasing. Information and financial relationships between logistics partners are becoming more complicated.
2. The number of links in logistics systems is being reduced. The number of organizational and economic relations in logistics systems is decreasing, but the complexity in them increases.
3. The reliability of supply chains (channels) decreases because of production and distribution networks; safety stocks are practically disappearing.

The consequence of these trends is an increase in the potential instability of the logistics system. To increase its stability and reliability while achieving strategic business goals, further integration is required both within the system itself and with a dynamic external environment. The logistics system (*according to the integral concept*) is considered as a whole – an integrated management system that realizes the goals of the business from the

supplier to the end consumer (buyer). Thus, in the integrated logistics systems of corporations, the material flow unites the entire life cycle of a product: from idea to design, then to production, distribution, sales, after-sales service, and again to repeat the period following changing customer demands.

Professor J. J. Bowersox notes that the term integrated logistics originated in the 1980s and gained widespread popularity in the 1990s, and explains that the integrated logistics system promotes products through a continuous and sequential chain of incremental value addition (Bowersox and Closs 1996). Added value means that each side of the logistics system ("three sides" in logistics) includes actions that increase the value of a product or service for those who will receive the goods. Therefore, the best business results are achieved by those organizations that use the concept of integrated logistics, which allows combining the efforts of the company "master" of the logistics process (its management personnel, structural units) and logistics partners for end-to-end management of the primary and accompanying flows in an integrated business structure.

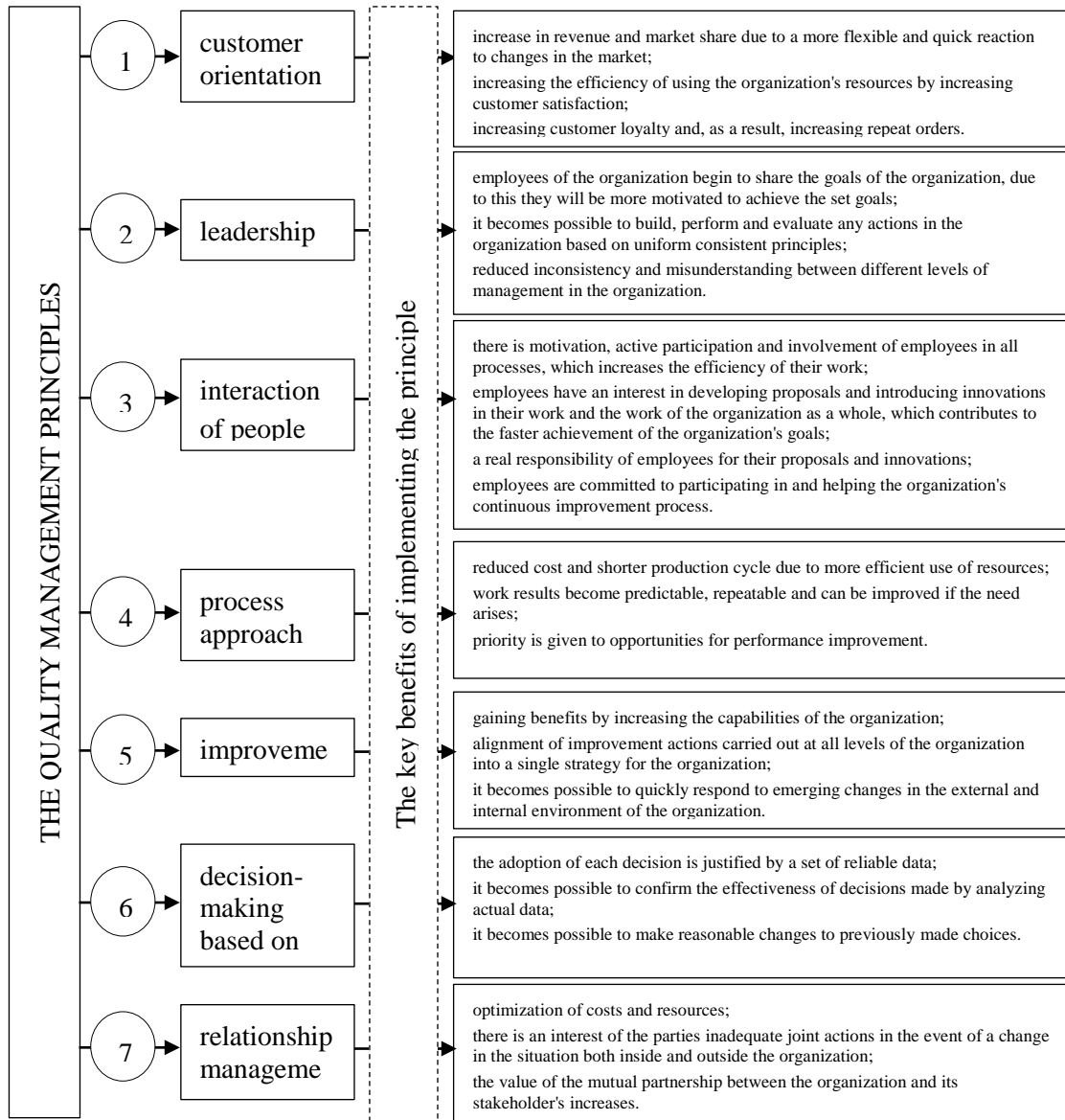
The personnel of logistics management ensures an increase in the organizational and economic stability of the company in the market in the course of cross-functional and inter-organizational coordination, which allows eliminating conflicts between company divisions and ensuring integrated interaction with logistics business partners.

This logistics concept presents logistics managers with the daunting challenge of overcoming the "localized" thinking that is characteristic of relatively isolated business units. Senior logistics managers play the role of cross-functional coordinators and, as such, view the functional areas of logistics as resources that need to be integrated into a single overall management system of the firm.

Thus, it is necessary to consider the basic principles of the management system from the standpoint of modelling the business processes of an enterprise.

### **2.3. Quality Management System: Principles**

ISO 9000 series standards reflect the ideology of quality management. This ideology is the basis for building and developing a quality system in any organization. The quality management system is based on 7 principles (the 2008 version contained 8 principles) (Fig. 2). The quality management principles are formulated rather briefly, but the idea embodied in the formulations of the principles is developed further in the specific requirements of ISO 9001. Each principle can be disclosed in several blocks of standard conditions.



**Figure 2** The quality management principles (authors’ development based on ISO 9001:2015, Lutfullaeva 2019)

For the first time, quality management principles were included in the 2000 version of the standards. These principles were formulated in ISO 9000:2000 “Quality Management System. Basic principles and vocabulary” (ISO 9000:2000).

1) *Customer orientation* (formerly a customer-focused organization) – the organization depends on its customers and therefore must understand the current and future needs of the customer, fulfil the customer's requirements and try to exceed the customer's expectations. The principle says that any organization is created to meet the needs of its customers. From a quality management point of view, all activities of an organization should be aimed at identifying, understanding and meeting customer needs.

2) *Leadership* (previously – management leadership) – leaders establish the unity of purpose, direction and internal environment of the organization. They create an environment in which people can become fully involved in achieving the organization's goals. To effectively accomplish the purposes of the organization, employees at all levels must not only want to achieve their goals but also be leaders in achieving these goals, be an example in striving for these goals.

3) *The interaction of people* (previously – the involvement of people) – employees of all levels – this is the essence of the organization and their full participation makes it possible to use their abilities for the benefit of the organization. People in an organization can work well and effectively only when they are passionate about their work when they are interested in it (Lutfullaeva 2019). To achieve quality goals, the organization must create the conditions for the maximum interest of people in the work they do. This can be achieved through effective personnel management.

4) *Process approach* – the desired result is achieved more efficiently when the corresponding resources and activities are managed as a system of interrelated processes. Any movement in the organization should be considered as a process; therefore, it should have clearly defined and unambiguous inputs, outputs, resources, operations and the relationship of all specified components of the process.

Earlier (in the 2008 version of the standards) there was one more principle – a systematic approach to management. The new version of the standards combined this principle with the principle of the process approach.

5) *Improvement* (formerly Continuous Improvement) – continuous improvement is the constant goal of the organization. This principle determines the need for constant development of the organization.

6) *Decision making based on facts* – the effectiveness of decisions is based on the logical analysis of data and information. Any arrangements, any control actions should be made only based on objective data, objective evidence, but in no way based on assumptions, conjectures or subjective opinions.

7) *Relationship management* (formerly mutually beneficial supplier relationships) – a mutually beneficial relationship between an organization and its stakeholders enhances the organization's ability to create value. This principle directs the organization to develop its relations with stakeholders. Each stakeholder influences the performance of the organization to one degree or another. If an organization can optimally build its relations with all stakeholders, then this will allow it to reduce both external and internal risks associated with performance.

The operation of the entire quality system will depend on how well the leaders and employees of the organization understand the principles of quality management.

Building a quality system by the ISO 9000 series allows an organization to implement the principles of quality management in its work practice. Each of the above principles is reflected in ISO 9001 by a set of requirements. Therefore, when an organization develops and implements methods to implement these requirements in its work, it thereby implements the principles of quality management.

### **3. METHODOLOGY: MODELLING OF TRANSPORT AND LOGISTICS CUSTOMER SERVICE**

Since the study cannot cover all business processes of the enterprise, the authors focused their attention on supply (logistics).

The development of guidelines for the formation and optimization of the transport and logistics system of enterprises is based on the selected logistics concepts of organization and theoretical approaches, as well as based on the identified contradictions, problems and trends in the development of the industry and the sphere of management.

As the analysis has shown, the main reasons for the imbalance in the production of goods and their transportation are the untimely performance of operations preceding the dispatch of the finished product by the vehicle from the manufacturer products).

Based on the conducted theoretical studies, two logistics concepts were identified, which to the greatest extent reflect the specifics of the formation of the transport and logistics system of enterprises: integrated and informational, realizing a systematic approach, an information-reproduction approach, a process approach and determining the achievement of the maximum effect. These concepts will be used in the construction of management models for the transport and logistics system.

Also, the modelling of business processes will take into account the principles of the management system:

- the system is considered in the context of its components: elements, subsystems, logistic flows due to the specifics of the operation of the enterprise and the variety of modes of transport used (rail, road, container transport, river and/or their combinations);
- the existence of entropy generated by all processes occurring in the transport and logistics system and associated with the loss of the system's ability to perform ordered actions to achieve the set goal (changes in the measure and content of the parameters of managerial impact reduce the degree of entropy);
- the presence of integrative properties of the transport and logistics system, determined by the logical, logistic, technological, material, informational and financial interconnections and interactions between its constituent elements and subsystems;
- the obligatory existence of goal-setting and purposefulness.

Thus, modelling a business process is reduced to a multicriteria decision-making problem. The essence of multicriteria decision-making problems: options-"candidates" are compared according to two or more criteria to find the best option (or one of the optimal, if the "first place" is shared by different "candidates"). There are various methods for solving multicriteria problems, but first one crucial step is required: an easy way to reduce the number of options, especially if there are many, i.e. to evaluate the options beforehand. One of the approaches to multicriteria decision-making problems is convolution by criteria. In addition to assessing opportunities for each of the criteria, it requires knowledge of the priorities of the criteria.

Suppose we have  $n$  criteria, while for option  $x$  the criteria are assessed as follows:

$$0 \leq f_i(x) \leq 1, i = 1 \dots n \tag{1}$$

If, according to the  $i$ -th criterion,  $x$  is a perfect option (at least other options are not better than it according to this criterion), then the score = 1, if disgusting, then 0, if the average value is somewhere between 0 and 1, for a more accurate calculation, use the formulas:

- if the indicator is direct, i.e. the bigger it is, the better:

$$f_n = \frac{f_{meas} - f_{min}}{f_{max} - f_{min}} \tag{2}$$

where  $f_n$  – weight  $n$  criterion;

$f_{meas}$  – the value of the measured indicator, conventional units



$f_{max}, f_{min}$  – respectively, the maximum and minimum value of the indicator, conventional units.

- if the indicator is reversed, i.e. the smaller it is, the better:

$$f_n = \frac{f_{max} - f_{meas}}{f_{max} - f_{min}} \quad (3)$$

The priorities (weights) of the criteria are as follows:

$$0 < p_i < 1, i = 1 \dots n; p_1 + \dots + p_n = 1 \quad (4)$$

The priorities are the same for all choices. The priority can be equal to zero or one, but this is undesirable (if one, then it turns out that we have only one criterion, not several; if zero, then, in fact, the criterion does not play any role).

The criteria convolution operator for option x is:

$$w(x) = g(f_1(x), \dots, f_n(x), p_1, \dots, p_n) \quad (5)$$

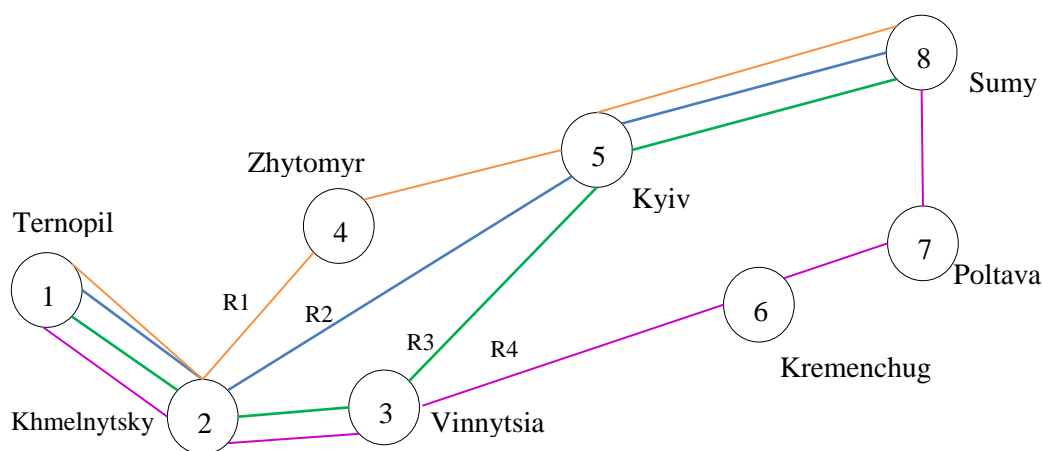
As can be seen, it is required to know not only the assessment by the criteria but also the priorities of the criteria.

## 4. CONDUCTING THE EXPERIMENT

### 4.1. Discussion

Let's demonstrate with a real example: the enterprise LLC "Ternopil Furniture Factory" (LLC "TMF") needs to deliver products from Ternopil to Khmelnytsky and Sumy.

Modelling the optimal route when planning cargo deliveries directly from Ternopil to Sumy suggested the best option: distance 834 km, approximate travel time: 11 h 54 min. Thus, the cargo will arrive the next day (with 1 obligatory overnight stay for the driver) or with an early departure on the same working day (with 2 drivers). However, the task requires the delivery of cargo to Khmelnytskyi, therefore, this option is not suitable, so the logistics department proposed four routes (Fig. 3).



**Figure 3** Variants of the route Ternopil-Khmelnytsky-Sumy (authors' development)

If we proceed only from the distance of the route, then the management should choose the shortest route, which, accordingly, will bring the least fuel costs. However, it is not so. The short route goes through secondary roads where the road surface is worse than, i.e. the level of roads (international roads, national roads, regional roads), road surface and permitted speed is not taken into account. Also, all routes pass through settlements, which leads to a speed limit for road transport. Thus, merely calculating logistics by the criterion of "economy" using only one indicator – distance – is not correct. The task is reduced to a multicriteria choice. For this, we will use additive convolution. The management chose (a simplified version) as criteria: delivery time, fuel consumption and mileage of "bad" roads. The logistics department, following these criteria, pre-calculated and proposed four most acceptable routes (Table 1).

**Table 1** Indicators of route variants Ternopil-Khmelnysky-Sumy

Route	Waypoints (Fig. 3)	Delivery time, h.	Fuel consumption, l.	Kilometers of "bad" roads, km.
R1	1-2-4-5-8	10:43	160	111
R2	1-2-5-8	10:16	168,3	153
R3	1-2-3-5-8	10:14	167,5	153
R4	1-2-3-6-7-8	11:12	190,2	0

At first glance, routes 2 and 3 are almost identical, so we evaluate additional parameters to exclude one of them. Because the company has recently renewed its fleet of trucks, the next important criterion will be the minimum number of "bad" roads,

R2: 398 km from 90 km/h, 236 km – 70 km/h, 183 km – 60 km/h.

R3: 417 km from 90 km/h, 248 km – 70 km/h, 153 km – 60 km/h.

Thus, R2 can be excluded from the assessment.

Without knowledge about the weights of the criteria, we cannot exclude at least some alternative: each is better in some way, and in some ways worse than any other.

Let's normalize the criteria without standards (Table 2). For the delivery time, we will use the formula (2): best = 10:14, worst = 11:12; for convenience, let's convert the time into minutes, so for R3 we get  $(643 - 614) / (672 - 614) = 0.5$ ;

For fuel consumption: the best – 160 liters., The worst – 190.2 liters. Because fuel consumption is the opposite criterion, i.e. the less, the better, we use formula (3), then, for R3 it will be  $(190.2 - 167.5) / (190.2 - 160) = 0.88$ ; Similarly, the mileage of "bad" roads: R1 will be  $(153 - 111) / (153 - 0) = 0.27$ ;

**Table 2** Routes criteria normalization

Route	Delivery time, h.	Fuel consumption, l.	Kilometers of "bad" roads, km.
R1	0,5	1	0,27
R3	1	0,75	0
R4	0	0	1

If we simply compare the indicators, then two routes are equally attractive: R1 ( $\Sigma = 1.77$ ) and R3 ( $\Sigma = 1.75$ ), R4 ( $\Sigma = 1$ ) is the least attractive, however, to make an informed management decision, it is necessary to prioritize and evaluate projects and their weights. The management of the enterprise thus prioritized the following: fuel consumption, kilometres of "bad" roads and delivery time.

These priorities are very subjective for several reasons: the delivery of goods is carried out at the expense of the manufacturer, respectively, the enterprise seeks to minimize its costs, if the delivery was carried out at the expense of the client, the delivery time would be more priority than the price; also, the company has recently renewed its vehicle fleet and seeks to spend as little as possible on depreciation, so it prefers that the cargo be transported on right quality roads.

Thus: for fuel consumption – 3 points, "bad" roads – 2; delivery time – 1. As a result:  $f_1 - 3/6 = 0.5$ ;  $f_2 - 2/6 = 0.33$ ;  $f_3 - 1/6 = 0.17$

As a result, we get that  $w(x) = 0.5f_1 + 0.33f_2 + 0.17f_3$

$$w(R1) = 0.5 * 0.5 + 0.33 * 1 + 0.17 * 0.27 = 0.63$$

$$w(R3) = 0.5 * 1 + 0.33 + 0.75 = 0.75$$

$$w(R4) = 0.17 * 1 = 0.17$$

As you can see, R3 follows. In this case, a factor that is usually not taken into account - the quality of the roads, had a special influence; nevertheless, this factor should be taken into account when calculating depreciation, which leads to an increase in the cost of transportation, as well as repair work.

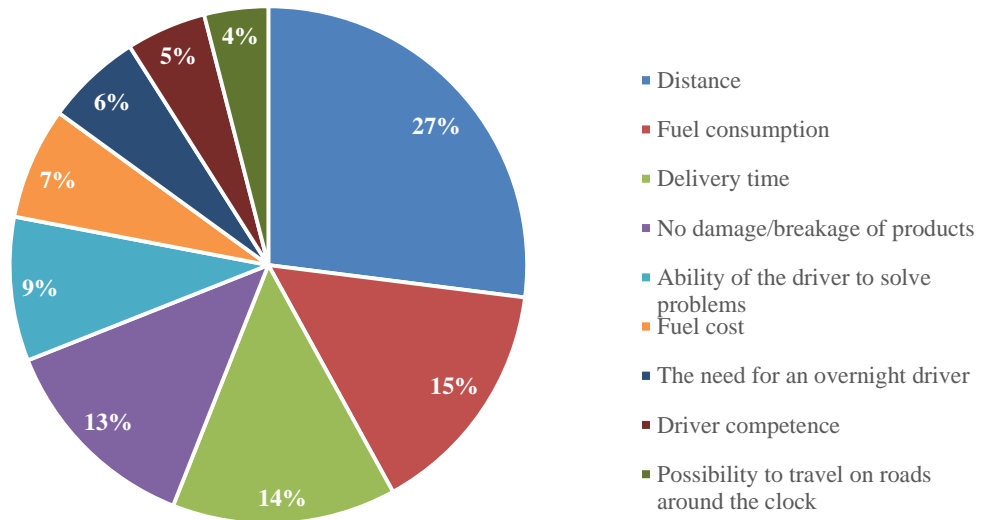
Thus, the optimal route, according to the criteria of the enterprise management, will look like this: Ternopil – Khmelnytsky – Vinnytsia – Kyiv – Sumy.

## 4.2. Discussion

The study showed that in addition to the specific features of the business process – in this case, the use of logistics concepts in logistics management, it is essential to implement the principles of the management system since it is management that makes management decisions.

Modelling a business process as a multi-objective decision-making problem has many ways to solve it, we have demonstrated the action of one of them. To illustrate the clarity of the methodology, some simplifications were introduced; however, even in our particular case, improvements are possible. So, for example, the management itself set the maximum and minimum criteria, because, for instance, according to our methodology, according to the criterion of the cost of transportation (UAH 1500, UAH 1450, and UAH 1400), the first project will receive 0, although in this case, the price is not much different from reference (minimum) option. Therefore, management should evaluate whether it is necessary to use standardization against a standard. This proves once again that with multitasking, the choice of methods, tools, technology is not so obvious and management intervention is necessary. That is why we carried out an additional analysis of the logistics criteria at the expense of the manufacturing enterprise (Fig. 4). The data were collected by interviewing 35 experts, including 22 people – management of manufacturing enterprises, 4 – management of logistics enterprises, 9 – scientists in the field of logistics aspects. The survey was open and contained a single question – to choose the 10 most essential criteria in your opinion that must be taken into account in the transport and logistics business process. Based on the results of the polls, 9 criteria were identified and evaluated (Fig. 4).

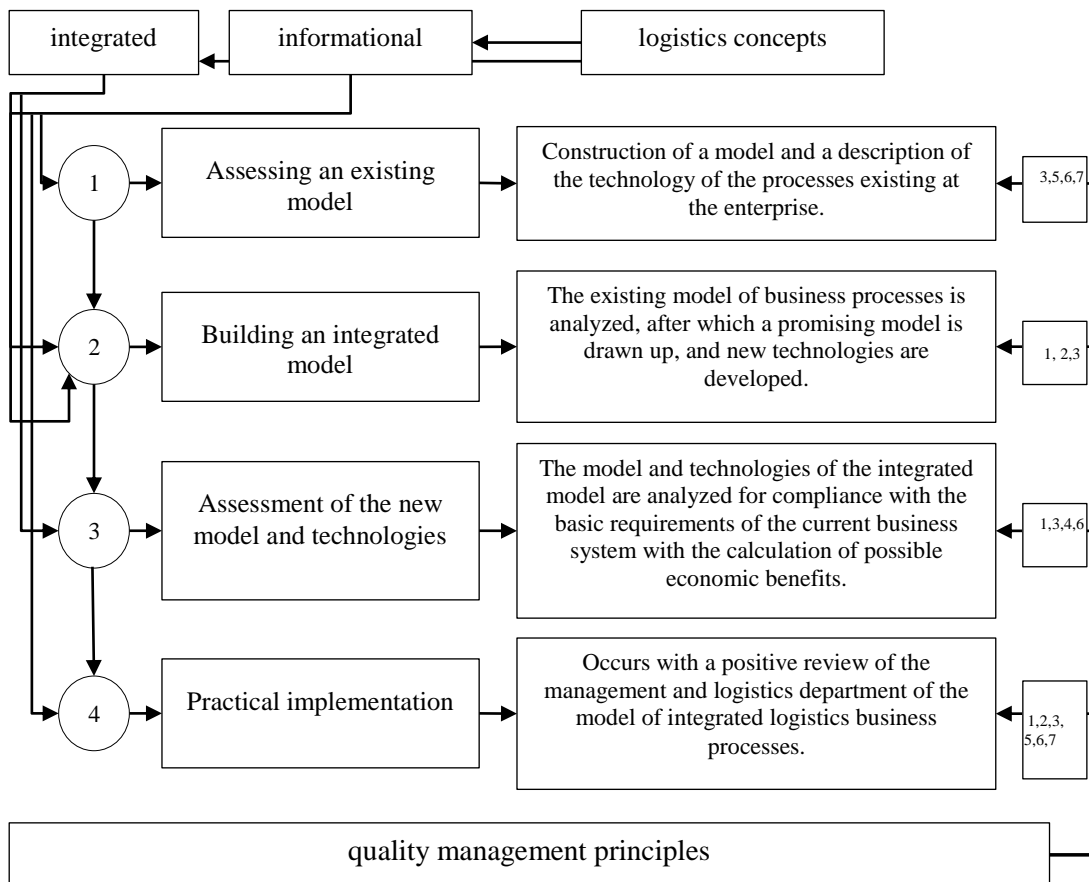
As you can see, in the average assessment of experts, there is no such criterion as the quality of roads. However, it was this criterion that was important for the management of the enterprise. Thus, the experiment carried out allows us to model the optimization of the logistics business process at the enterprise.



**Figure 4** Expert assessment of the most significant criteria of the transport and logistics business process (authors’ development)

### 5. RESULTS

Based on the theoretical and methodological research and experiment, the authors propose the following model (Fig. 5).



**Figure 5** Modelling business processes based on logistics concepts and management system principles (authors’ development)

First of all, this model was developed for the transport and logistics business process; one with minimal adjustments can be applied to almost any business process of an enterprise. Moreover, such logistic principles as informational and integral, in the modern world of active management are applicable not only to logistics, and the principles of the quality management system are universal for managing absolutely all business processes of an enterprise.

## 6. CONCLUSION

The study showed the need for management participation in all business processes, as well as the need to apply the principles of the quality management system and specific concepts of the business process. Further research can be the development of software for evaluating the effectiveness of increasing efficiency and optimizing the modelling of business processes.

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