Building Functional Diagram of Cargo Delivery to Describe and Research Processes in Freight Forwarding Company based on the IDEFO Standard (SADT)

E V Kiseleva¹, T B Dambiev¹, V E Stepanets², S S Valkova³

¹Department of Mechanical Engineering, Marine Engineering and Transport, Engineering Department, Polytechnic Institute (School), Far Eastern Federal University, 8 Sukhanova St., Vladivostok, 690090, Russia
²Department of Vehicle Management, Faculty of Engineering and Technology, Private Educational Establishment of Higher Education «Far Eastern Institute of Communications» (FEIC), 7 Kaplunova St., Vladivostok, 690013, Russia
³Department of Operation and Management of Transport, Naval Institute, Federal State Funded Educational Institution Higher Education «Far Eastern State Technical Fisheries University» (Dalrybvtuz), 52B Lugovaya St., Vladivostok, 690087, Russia

E-mail: kiseleva.evi@dvfu.ru

Abstract. This article exposes the prospects of using structured analysis and design technique (SADT), its advantages and capacities for the study of processes in a freight forwarding company to improve the quality system for consigner service provision. We review the modeling of high-capacity container (HCC) transportation by a transport and logistics company using the SADT method and IDEFO notation, as well as the efficiency of using the SADT methodology to describe and research freight forwarding processes that can be confirmed by the list of its key application areas.

1. Introduction
This article exposes the prospects of using structured analysis and design technique (SADT), its advantages and capacities for the study of processes in a freight forwarding company to improve the quality system for consigner service provision.

The improvement of business processes of a freight forwarding company is a set of works affecting various aspects of company activities and its subsystems including strategic management, production, logistics, personnel management, internal communications, document circulation, etc. Thus, the introduction of a quality system is a complex, prolonged, and labor-intensive goal [1].

Today, freight forwarding companies have to improve their service provision technology, service quality assurance, and production efficiency through the formation of business processes to obtain a competitive edge [2].

The improvement of the quality of business processes at the company may result in the following:
- regularized document circulation;
- consistent and correct introduction of new employees to the workflow;
- optimization of all processes;

...
2. The problem of modeling and developing business processes to improve processes in a freight forwarding company

Transport flow management and organization involve many of the participants of the logistics system. The systemic approach is the methodological basis for the workflow organization. It is based on viewing objects as systems. The systemic approach helps to view the phenomenon in question as a set of interrelated subsystems serving a common purpose [5].

The development and improvement of business processes at a transport company is a labor-intensive and prolonged process stipulating the implementation of a number of activities and works that can be divided into stages: organizational, basic, final, improvement. This corresponds with the Deming Cycle of continuous improvement (also known as the PDSA - Plan-Do-Check-Act - Cycle) [6]. Thus, to implement an efficient quality system at a transport company, we must view this company using the process-based approach to identify the business operations that require control and improvements.

3. Research methods

Using the process approach, we aimed to determine design processes for cargo shipment services. Process management is used to satisfy clients’ needs. As a result, managing process results turns into managing the shipment process itself.

To solve these problems, we review the prospects of the structured analysis and design technique (SADT) that is well-known among IT specialists and is an evolution of systemic analysis. This methodology became widespread in designing information systems for various applications and it is the basis of international and Russian standardization activities [7].

The SADT method (IDEF0 notation) is a classic method used in the process approach to management. Its key advantage is the correlation of the approach with the ISO 9000 process description. Currently, the most widespread and extensively used methodologies are IDEF0 and IDEF1 (IDEF1X) that became federal standards in the USA. In Russia, they were released as the guideline document on standardization in 2000 [8]. The advantages of this method include its versatility and simplicity, accessible graphic language, and the possibility of using it during the first stages of the information system life cycle. Its key advantage is that its fundamental nature for the international and Russian standardization activities makes it the best option for modeling different systems, including those of transport processes.

During the first stage of description, it is necessary to identify the business processes at the company. The key element in process identification is the setting of the goal that reflects the reason for the business process model (description) creation and determines its purpose. To identify business processes, it is necessary to identify the following:

- the consumers of the company services;
- the services provided by the company and supplied to clients;
- types of resources and their suppliers;

During the second stage of the business process identification, it is necessary to describe its internal structure. To do that, it is necessary to determine the following [9]:

- the constituent processes of the modeled business process;
- the way these processes interact with each other.

The third stage of business process identification is the description of interactions between processes.

The goal of a quality system model for a transport company is to identify the top priority actions to reduce costs and improve the quality of transportation. Further on, it is necessary to construct an upper-level diagram and an aggregate diagram, and then perform their critical assessment and make amendments if necessary.
4. Results
The IDEF0 methodology is based on the graphic language of process description. The model in IDEF0 notation is a set of hierarchically structured and interlinked diagrams. Each of the diagrams is a unit of system description and is shown on a separate sheet.

**Context diagram** (upper-level diagram) is at the top of the tree structure of diagrams and it shows the purpose (the key function) of the system and its interactions with the external environment. Each of the models may only have one context diagram. After the key function is described, functional decomposition is performed, i.e. The identification of the functions comprising the key one[10]. An example of an organization diagram for a high-capacity container (HCC) is shown in Figure 1.

![Diagram](image)

**Figure 1.** Upper-level diagram (context diagram) for HCC shipment organization.

Then the functions are divided into subfunctions until the required level of detail is achieved for the system in question. Diagrams describing each of such fragments of the system are called **decomposition diagrams**. After each of the decomposition sessions, auditing sessions are conducted, during which experts in the specified area say whether real processes comply with the developed diagrams. Any identified non-compliances are eliminated, after which the processes are detailed further [11]. An example of a first-level decomposition diagram is shown in Figure 2.
Figure 2. First-level decomposition diagram for the HCC shipment organization.

Diagram A0 shows the Decomposition of the container transportation model as 6 processes. Diagram A0 is the first level of decomposition (detailing) for this process. Of all the processes shown, only 6 can be decomposed further with the top codes A1-A5 [12,13].

The shipment of the container within Russia can be divided into two aspects:
- shipment within the Far Eastern Region, i.e. the shipment of a high-capacity container (HCC) only by trucks within the Far Eastern region.
- shipment to the central part of Russia, i.e. The shipment of a high-capacity container (HCC) by two transport modes: railroad trains and road trucks.
Each of the aspects features specific business processes. Diagram A5 (Figure 3) shows Shipment within Russia including two shipment aspects and eight processes (A51-A58) [14].

The IDEF0 methodology allows for 5 (five) types of interactions between blocks within one diagram [15]:
- control;
- output to input;
- control feedback;
- input feedback;
- output to the mechanism.

In our case, it is the control link when the output of one process impacts the implementation of another process. In ISO 9001-2015, such interaction determines the Managers’ Responsibility control function for other processes [16].

The number of process detailing levels is determined, firstly, by the goals of modeling, and, secondly, by the specific features of the modeled organization's activities [17].

**Figure 3.** 2nd-level decomposition (shipment within Russia).
5. Conclusion
To describe the HCC shipment, we selected the SADT methodology (IDEF0 notation) as part of constructing the functional diagram of the business processes (cargo delivery) of a freight forwarding company. The functional model reflects the functional structure of the processes comprising the company operations. It is used to formalize the knowledge of the structure of company activities, the analysis of the current state of activities, the identification of bottlenecks, and designing the perfect state of the functional structure.

After that, we suggest using the basic quality control tools like checklists, Pareto charts, and Ishikawa diagrams to identify incompliances and mistakes in the operations of the transport company in question [19].

This approach helps significantly reduce the mistakes at the early stages of system development and improve the interactions between consignors and consignees. The model easily reflects such parameters as control, feedback, and implementers [19].

Thus, the idea of constructing a functional diagram of cargo delivery by a freight forwarding company within an SADT model can help the transport company borrow the basic aspects:
- the orientation on the consumers and service utility, which requires stable feedback;
- the continuous improvement of the services rendered to increase the competitive ability [20].

6. References
[1] Hammer M, Champy J 1997 Corporate Reengineering: A Manifesto of the Business Revolution Per. from English (SPb.) St. Petersburg University Press 332
[2] Harrington D, Esseling K, Nimwegen H 2002 Optimization of business processes Documenting, analysis, management, optimization (SPb.: ABC. BMikro) p 328
[3] Dremina M 2015 A Project approach to the development and implementation of quality management systems: monograph (St. Petersburg: Lan) p 303
[4] Shcherbakov V V 2016 Automation of business processes in logistics: for bachelors and masters: a textbook for university students, training. by direction "Logistics and supply chain management" "Commerce", "Trade business" (SPb.: Peter) p 464
[5] Repin V V 2013 Business processes. Modeling, implementation, management (M.: Mann) Ivanov and Ferber p 512
[6] Muzalevskaya A A 2014 Information support of the quality management system Economic environment 4(10) pp 54–59
[7] Romanov V N 2006 Systems analysis for engineers (SPb: SZGZTU) p 186
[8] Skripko L Ye 2015 Principled" view of quality management Methods of quality management. – 2 pp 10-17
[9] Methodology and order on the work on the definition, classification and identification of processes Description of processes based on the IDEF0 methodology: BGPA Department of Standardization, Metrology and Information Systems PS SERENKOV (Minsk) p 57
[10] Mark D A, McGowan K 1993 Methodology of structural analysis and design SADT (Moscow) p 191
[11] Meshcheryakova A A 2018 Methodology of functional modeling SADT Actual directions of scientific research of the XXI century: Theory and practice Voronezh State Forestry University named after G.F. Morozov (Voronezh) Vol 6 7(43) pp 66-70
[12] Vendrov A M 2005 Software design of economic information systems: textbook 2nd ed. Rev. and add. (Moscow: Finance and Statistics) p 544
[13] Methodology of functional modeling IDEF0 [Electronic resource]: guidance document 50-682-89 (Moscow: Gosstandart of Russia) Access mode: http://www.staratel.com/iso/IDEF/IDEF0/IDEF0Rus.pdf
[14] Gavrikov V A, Penshin N V 2016 Analysis of indicators of the quality of motor transport services UNIVERSITY im. IN AND VERNADSKY 2(60) pp 69-78
[15] Kiseleva E V, Dambiev T B, Matveev I A 2020 Using the methodology of structural analysis
and design (SADT) to study the problems of the quality of transport services *Logistic audit of transport and supply chains* Materials of the III International Scientific and Practical Conference (Tyumen TIU) pp 256-262

[16] Boldyrev A V 2009 Improvement and development of the quality management system of services of a transport organization: abstract of the dissertation of the candidate of economic sciences. 08.00.05 (Tambov) p 182

[17] Shcherbatykh A N 2014 From the quality of documentation to the quality of products *Standards and quality* 7 pp 88–89

[18] Kiseleva E V, Dambiev T B 2019 Application of statistical tools for quality control in the system of optimization of the operation of a motor transport enterprise Logistic audit of transport and supply chains Materials of the II International Scientific and Practical Conference (Tyumen TIU) pp 284-291

[19] Yashin N S 2016 Development of the methodology for analyzing the effectiveness of the quality management system of industrial enterprises *Bulletin of the Saratov State Social and Economic University* 4(63) pp 51–56

[20] Batynova A A, Makarova L V, Tarasov R V 2015 Designing the process of managing the costs of quality *Young scientist* 13 pp 358-361 URL https://moluch.ru/archive/93/20584/