DOI: 10.32347/2412-9933.2022.49.26-32
UDC 004.03

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REPRESENTATION OF COMFORT INDICATORS BY MEANS OF DFD-DIAGRAMS

Abstract. *A study was conducted using the Dataflow diagramming to describe the information flows of the subject area "Comfortable living in an apartment building", where the construction process is presented in the form of a decomposition diagram and construction of a context diagram of the 0th level. Therefore, the DFD chart includes the following indicators of comfort: 1. Factors of comfortable living in the neighborhood. 2. Factors of comfort of the house territory. 3. Factors of home comfort. 4. Factors of apartment comfort, as well as a description of external entities (expert, buyer, construction company) and their impact on all indicators of comfort. Next, we present and describe the input and output data streams in which information is determined and transmitted from the source (process, external entities) to the receiver (external entities, processes). After constructing the context diagram, we obtained a complex system, which is further presented in the form of a hierarchy of the context diagram of the 1st level and contains a set of four subsystems and is connected by data streams and form data warehouses (environment, fuzzy set, norm), which are the prototype of the future database. As a result of research of the DFD chart of the 1st level we received: 1. The main functions are defined. 2. Described objects. 3. The main data streams are defined. 3. Creating an information system using data warehouses. The following is the 2nd level of the DFD chart and we use it for a detailed description of the information system, which provides an opportunity to consider in more detail the work of the designed system "Comfort of the neighborhood", namely the detail of the lower level process. Accordingly, each process coexists with the top-level process and I use the structural process numbers. We detail the process of the DFD chart of the 1st level 1.2, which contains 2 processes: (processing pedestrian accessibility, 1.2.2 Processing noise level) and describes the hierarchy of input and output data streams into the system. Next, we move from data warehouses to building a database model, which we present in the form of such diagrams (conceptual model, data model and physical model). The first step is to build a conceptual design, which is described using a table called "Attributes of entities and the relationship of entities). The second stage is the creation of a data model based on the created "Connection of entities", and has the following external keys: (norm, fuzzy set, linguistic variable). Next, we present a physical model where Microsoft SQL Server was processed and the data types are specified accordingly.*

Keywords: information technology; conceptual model; data model; physical model; DFD-diagram; attributes; entities; data warehouses

Introduction

Modern development of AIT (automated information technology) is quite rapid with the advent of new technical means of processing and transmission of information and provides a wide range of direct product development and management systems [1].

Therefore, CASE tools supported by the DFD (Dataflow Diagram) methodology are available for business process analysis. In turn, they are quite powerful software for creating information models that allow us to analyze and plan more complex business processes. DFD functional systems are a set of process elements that have the ability to interact with each other and can show information, human and other resources that can be used by work.

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The main idea is to build a hierarchical diagram, ie a description of information, human or other resources, fragments. First of all, the description is made as a whole, namely (context diagram), then the decomposition is carried out, ie we divide it into subsystems and describe each subsequent subsystem separately. The next step is to break each decomposition diagram into smaller ones until the analyst reaches the desired level of detail.

Therefore, the main components of this chart are:

- external entities;
- systems and subsystems;
- data warehouses;
- data flows.

The generalized diagram of DFD-0 level "Determining the comfort of an apartment building" is the most important step in creating a design information system that allows you to determine the main objectives of the system and check the completeness of the external factors of the system and perform final model approval [2].

Dataflow Diagram used in this paper to evaluate the model and serves to determine the factors of "Comfort of living environment". Typically, this chart is used to understand the origins of comfort factors for an apartment building

The goal of the work

The purpose of the article is:

1. Creating a context chart DFD to describe "Comfortable living in an apartment building"

2. Construction of the 2nd level of the DFD diagram on the basis of the conceptual model of the 1st level.

3. Construction of a database model, which will be presented in the form of the following diagrams (conceptual, data, physical.

Presenting main material

The DFD (Data flow diagramming) diagram is used to describe the information flows of the subject area "Comfortable living in an apartment building". Details of the construction process are presented in the form of decomposition diagrams. Accordingly, the first step is to construct a level 0 context diagram [3].

Figure 1 shows the overall process of the Determine Home Comfort system for an apartment building, which lists the external objects that are the source and receiver of information through data streams.

Therefore, this general process of the DFD chart includes the following cumulative comfort indicators, namely:

1. Factors of comfortable living in the neighborhood;

1.1 Elements of social, transport, recreational infrastructure [1].

2. Factors of comfort of the house territory;

2.1 Characteristics of the common area and adjacent territory;

2.2 Elements of social infrastructure that are within walking distance of the apartment building [1].

3. Factors of home comfort;

3.1 Materials, planning, application of various urban planning solutions and modern technologies that affect human well-being and health. [1].

4. Factors of comfort of the apartment.

4.1 Characteristics of living space.

External essence is: organization (construction company, expert), individual (buyer).

The description of external entities will be presented in the form of table 1.

*Table 1 – **Description of external entities***

External entities	Description of entities
Expert	Exercises full control over the design of the construction of an apartment building and evaluates the existing all the factors of comfort of the living environment.
Shopper	The future resident (individual) of a highrise building, who, guided by data from an expert on the comfort of a house, chooses housing to his liking.
Construction company	Provides and realizes the needs of conditions of increased comfort for the life of the population in the field of design, architecture and construction.

Next we describe the input and output data streams, which determines the information transmitted from the source (processes, external entities) to the receiver (external entities, processes).

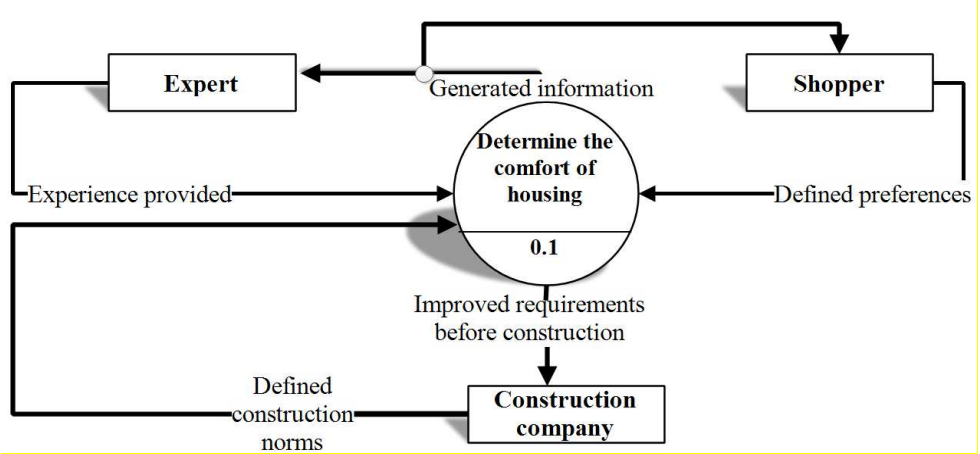

Figure 1 – 0th level of the DFD chart to determine the comfort of an apartment building

Incoming data streams:

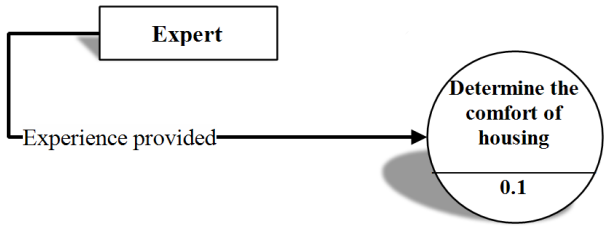

Figure 2 – Inbound data stream expert

The expert examines all the objective and subjective data on the comfort of the apartment building and provides the system with its assessment in the form of its own subjective experience of the housing [4].

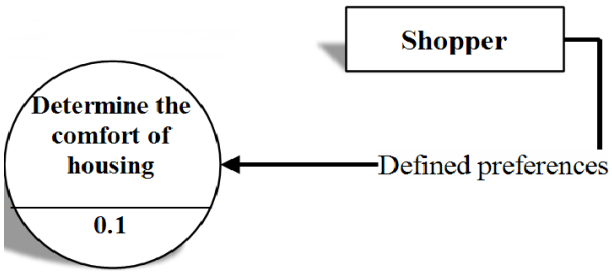

Figure 3 – Inbound data stream shopper

The buyer after the data provided by the expert on the factors of comfort, gives the system its defined preferences (personal wishes of the client).

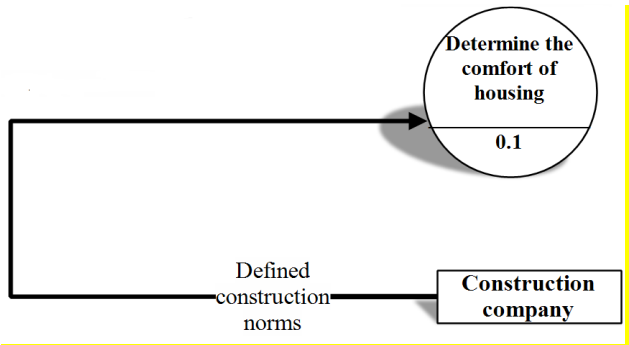

Figure 4 – Inbound data stream construction company

The construction company introduces into the system certain building codes, state standards and regulations [2]).

Output data streams

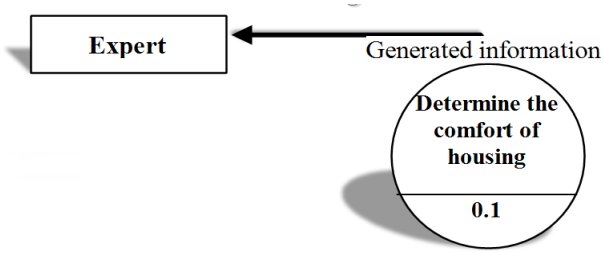

Figure 5 – Output expert data stream

After checking, the system provides the expert with information about the comfort of the apartment building [5].

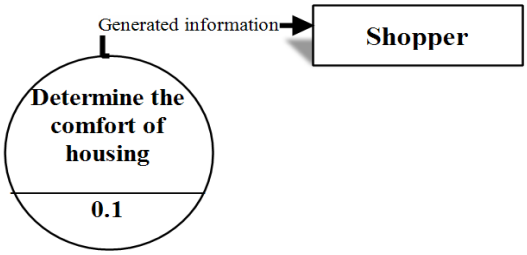

Figure 6 – Output shopper data stream

The system provides accurate and complete information to the buyer about all the comfort factors that are present in the living environment [7].

The system ensures the reliability, comfort and safety of the living space of construction sites [3]).

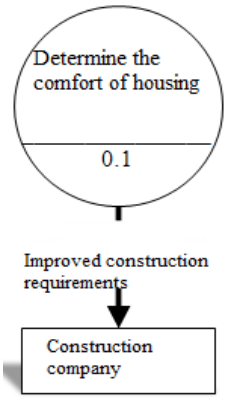

Figure 7 – Output construction company data stream

The system ensures the reliability, comfort and safety of the living space of construction sites [3]).

Thus, we have a complex system that cannot be shown by a single level 0 context diagram. It can then be represented as a hierarchy of Tier 1 context charts, which will contain a set of subsystems and be connected by data streams, this chart model will be presented in the next article.

Next, Figure 8 shows the 2nd level of the DFD chart. This level is used for a more detailed description of the information system, which serves to record specific details about the work of the designed system "Comfort of the neighborhood", ie detailing the DFD process of the lower level [6].

In this construction of the DFD chart hierarchy, each process is correlated with the top-level process and structural process numbers are used. In this case, we detail process 1.2 on the first level diagram, which contains two processes, namely:

- **1.2.1** work out pedestrian accessibility;
- **1.2.2** process the noise level.

We provide a hierarchy of input data streams into the system, which is shown in table 2.

Table 2 – ***Hierarchy of data flows***

Incoming data streams	Processes
Experience provided	1.2.1
	1.2.2
Defined preferences	1.2.1
	1.2.2
Defined building codes	1.2.1
	1.2.2
Processed information on the neighborhood	1.2.1
	1.2.2
Permission for further work was granted	1.2.1
	1.2.2

First of all, the expert studies the factors of comfort in terms of functionality, namely, which includes in its parameters the adjacent territory. And then sends your experience to the system [8].

The buyer contributes to the system their defined preferences, which cover two processes 1.2.1. and 1.2.2.

The construction company offers the system based on the research and preferences of the two above-mentioned entities defined building codes for the selected processes.

Figure 2 shows that between processes 1.2 and 1.3 (comfort of the house and comfort of the house) is used to simulate the transfer of information from one part of the system to another (processed information about the house), which allows the system (if all requirements are met by DBN) to move and work with factors of another process.

Therefore, after process 1.2.1 has been adjusted by external entities, the system grants permission to continue working with process 1.2.2.

Thus, the designed information system received from external attributes all the factors necessary for the comfortable living of the future occupant of the apartment building. In turn, having worked out all the necessary factors, we have the output data, which are presented in table 3.

Table 3 – ***Hierarchy of source data streams***

Incoming data streams	Processes
Processed data	**1.2.1**
	1.2.2
Generated information	**1.2.1**
	1.2.2
Processed information about the adjacent territory	**1.2.1**
	1.2.2
Defined name	**1.2.1**
	1.2.2
Defined data	**1.2.1**
	1.2.2
Improved construction requirements	**1.2.1**
	1.2.2

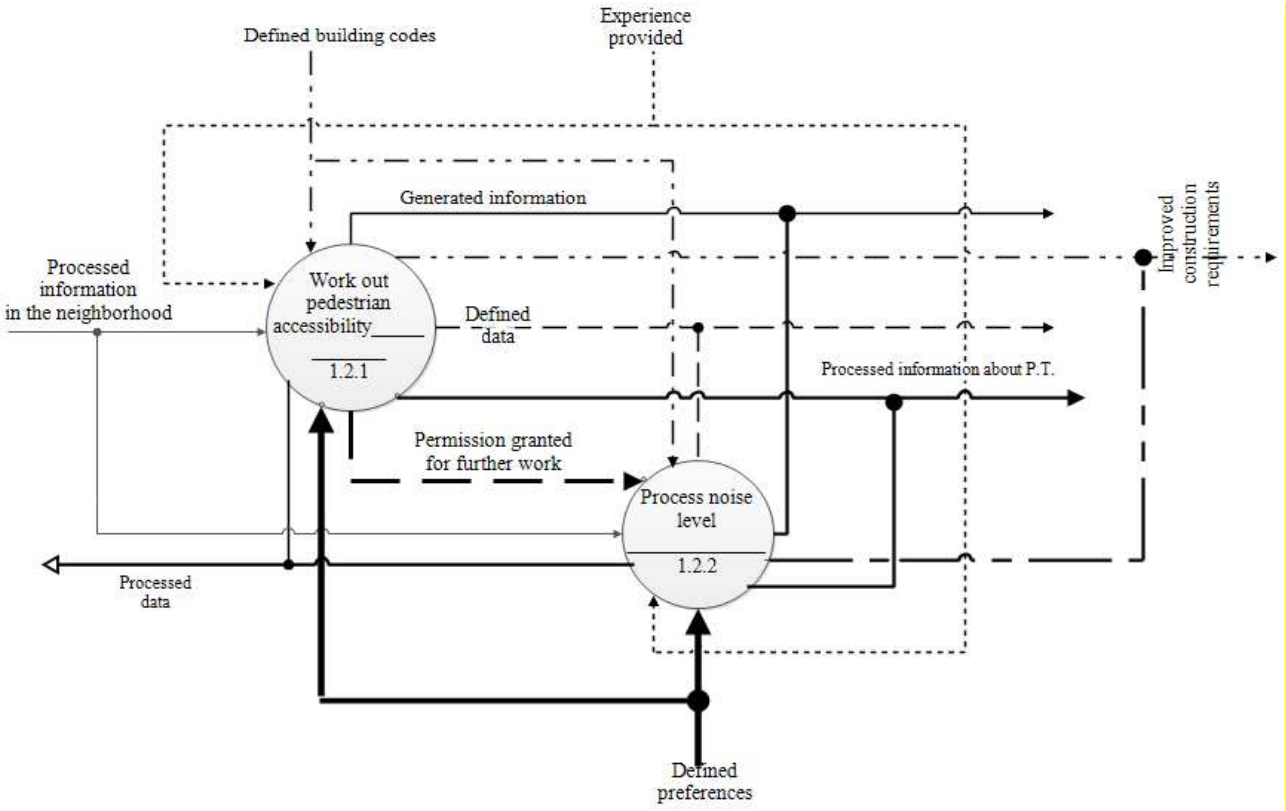

Figure 8 – Level 2 DFD chart for the comfort of the neighborhood

Let's move on from the data warehouses presented in diagram №1 (Fig. 2) to the database model, which is represented by the following diagrams:

– conceptual model;
– pathological model;
– physical model.

Accordingly, the conceptual model is presented in Figure 9.

The data model is presented in Figure 10. Based on Table B, the following tables will have foreign keys:

– norm;
– fuzzy set;
– linguistic variable.

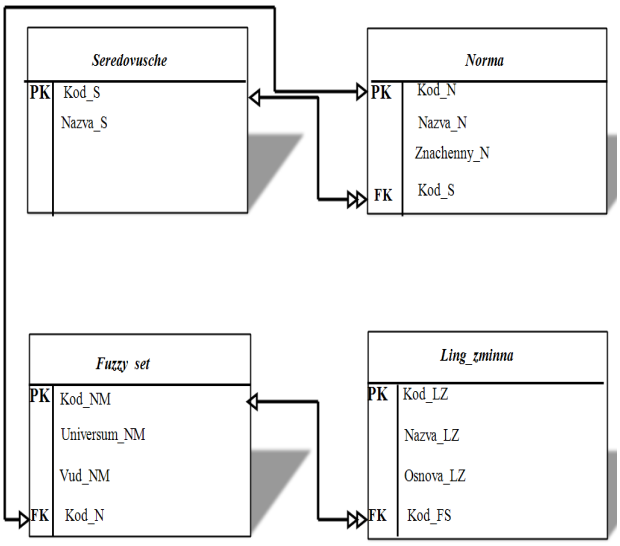

Figure 9 – Datological model

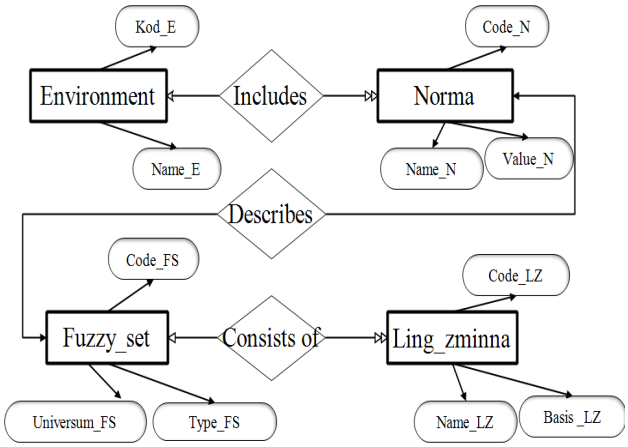

Figure 10 – Conceptual model

We describe it using tables №A and №B.

Figure 11 shows the physical model. As a DBMS, Microsoft SQL Server was processed and according to it the types of data to columns of tables are specified.

*Table A – **Attributes of entities***

№	The name of the entity	Attributes	Description
1.	Environment	Code_C	Field containing data about environmental identifiers.
		Name_C	Field containing the names of the environments.
2.	Norm	Name_H	Field containing the names of the rules.
		Value_N	Field containing the value of the norm.
		Code_H	Field containing data on norm identifiers.
3.	Fuzzy set	Code_NM	A field containing data about fuzzy set identifiers.
		Type_NM	A field containing the form of a fuzzy set.
		Universum_NM	A field containing a universe of fuzzy set.
4.	Linguistic variable	Code_LZ	A field that contains data about the identifiers of the linguistic variable.
		Name_LZ	A field containing the names of linguistic variables.
		Basis _LZ	A field that contains the basis of a linguistic variable.

*Table B – **Relationship of entities***

№	The essence of 1	The essence of 2	Commu-nication	Description
1	Environment	Norm	Includes	The environment includes several norms.
2	Norm	Fuzzy set	Describes	A fuzzy set is described by one rule.
3	Fuzzy set	Linguistic variable	Consists of	A fuzzy set includes several linguistic variables.

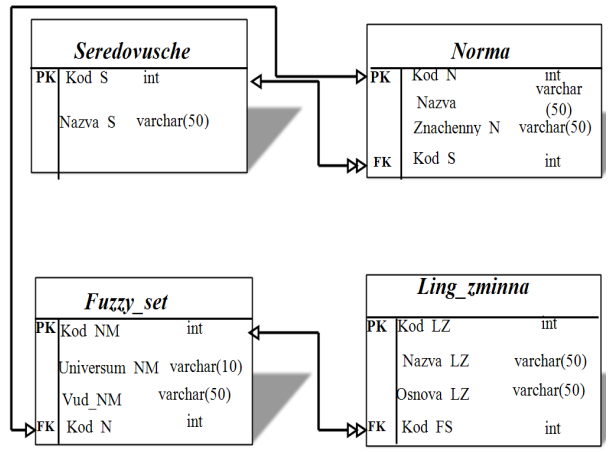

Figure 11 – Physical model

Conclusion

1. Thus, the hierarchical ordering of parts of the four subsystems is described with the help of symbols. 1. Determine the comfort of the neighborhood (VKM), described in pedestrian accessibility.

2. Determined the comfort of the adjacent territory (VKPT) this comfort factor is divided into pedestrian accessibility from 1 min to 5 min and a comfortable noise level of DB:

3. Determined the comfort of the house (VKB), which is determined by the following indicators, which are measured by the current technical condition:

4. Determined the comfort of the apartment (VKK)

Which in turn is divided into:

1. dimensionality;
2. convenience.

We see that some data streams have moved from a context chart to a Tier 1 chart, but internal input and output arrows are also being formed, and repositories are emerging as prototypes for future databases such as:

- environment;
- fuzzy set;
- norm, which are determined as follows.

Environment which means (neighborhood, neighborhood, house, apartment);

Fuzzy set by which is meant (universal set, type of linguistic variable);

Norm by which is meant (name, meaning).

The following are the objects of external essence: the expert, the buyer, the construction company, which indicate that they are outside the analyzed information system [10].

Description of functional requirements of processes:

Expert

Investigates each process and provides the system with experience on comfort factors that affect comfortable living conditions, taking into account current construction trends

Shopper

Carefully selects and compares in general the conditions of comfort of the neighborhood (external factors), adjacent territory (residential infrastructure), type of house, size and layout of the apartment and gives the system its defined preferences

Construction company

Provides and follows certain building codes, in urban planning activities, for the formation of comfortable living for future residents.

Description of the original data streams

Expert

The system provides the generated information to the expert about all the positive factors that affect comfort.

Shopper

The system, having formed the information provided by the buyer, allows the subject (person) to get a complete answer about the present subjective (satisfaction or dissatisfaction) and objective assessments of comfort

Construction company

The automated system, having collected all the data from previous subjects, offers a generalized algorithm for improved construction requirements. (Analysis of the results of previous studies. Establishment of the main parameters of the relationship between internal and external requirements for comfortable living in an apartment building)

Thus, as a result of the study of the DFD - Level 1 information chart, which was created on the basis of the Level 0 context chart, we can say that:

- the main functions of the designed system are defined;
- described objects that are modeled by business processes;
- identified data flows that are processed by business processes;
- completion of the information system is the description of the object using data warehouses.

References

1. Kucherenko, E. I., Kucherenko, V. E., Glushenkova, I. S. & Tvoroshenko, I. S. (2012). Methods, models and information technologies for assessing complex statesobjects: monograph. Kharkiv: KNAMG: KNURE, 278.

2. Luger, J. F. (2003). Artificial Intelligence: Strategies and Methods of Solutioncomplex problems. Moscow: Williams Publishing House, 864.

3. Bodyansky, E. V. & Kucherenko, E. I. (2006). Neuro-phase models in artificial intelligence systems: textbook manual. Kharkiv: HTURE, 177.

4. Kucherenko, E. I. (1999). Grid models in the problems of analysis of complex systems: textbook. manual for universities. Kharkiv: HTURE, 99.

5. Gavrilova, T. A. & Khoroshevsky, V. F. (2000). Bases of knowledge of intelligent systems. Saint Petersburg: Peter, 384.
6. Tomashevsky, V. M. (2005). Modeling of systems. Kyiv: Publishing group BHV, 352.
7. Kucherenko, E. I. & Tvoroshenko, I. S. (2010). Applied aspects of fuzzy process modeling in complex systems. *Bulletin of KHUVS*, 1 (23), 127–131.
8. Sovetov, B. Ya. & Yakovlev, S. A. (2001). Modeling of systems. Moscow: High School, 343.
9. Methods, models and information technologies for assessing the state of complex objects: a monograph [Electronic resource]. Retrieved from: http://eprints.kname.edu.ua/29457/.
10. Tsiutsiura, Svitlana, Yerukaiev, Andrii & Kostyshyna, Nataliia. (2021). Use of fuzzy Petri networks for information description of the housing environment. *Management of Development of Complex Systems*, 45, 170–175, dx.doi.org\10.32347/2412-9933.2021.45.170-175.

The article was received by the editorial board 17.02.2022

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ПРЕДСТАВЛЕННЯ ПОКАЗНИКІВ КОМФОРТНОСТІ ЗА ДОПОМОГОЮ DFD-ДІАГРАМИ

Анотація. *Проведено дослідження за допомогою діаграми Date flow diagramming для опису інформаційних потоків даних предметної області «Комфортне проживання в багатоквартирному будинку», де процес побудови представлений у вигляді діаграм декомпозицій і побудови контекстної діаграми 0-го рівня. Отже, діаграма DFD включає в себе такі показники комфортності: фактори комфортного проживання в мікрорайоні, фактори комфортності прибудинкової території, фактори комфортності будинку, а також фактори комфортності квартири, де проводиться опис зовнішніх сутностей (експерт, покупець, будівельна компанія) та їх вплив на всі показники комфортабельності. Далі представлено та описано вхідні й вихідні потоки даних, в яких визначається інформація і передається від джерела (процес, зовнішні сутності) до приймача (зовнішні сутності, процеси). Після побудови контекстної діаграми отримано складну систему, яка надалі представлена у вигляді ієрархії контекстної діаграми 1-го рівня, містить в собі набір чотирьох підсистем і поєднується потоками даних. Далі формуємо сховища даних (середовище, нечітка множина, норма), які є прототипом майбутньої бази даних. У результаті дослідження діаграми DFD 1-го рівня отримано: 1. визначені головні функції; 2. описані об'єкти; 3. створення ІС за допомогою сховищ даних. Після цього представлено 2-й рівень діаграми DFD, яку використано для детального опису ІС, яка надає можливість більш ґрунтовно розглянути роботу проєктованої системи «Комфортність прибудинкової території», а саме деталізація процесу нижнього рівня. Відповідно кожний процес співіснує з процесом верхнього рівня і використовуються структурні номери процесу. Деталізуємо процес діаграми DFD 1-го рівня 1.2, яка містить в собі два процеси: (1.2.1 опрацювання пішохідної доступності, 1.2.2 опрацювання рівня шуму), а також описана ієрархія вхідних та вихідних потоків даних у систему. Отже, переходимо від сховищ даних до побудови моделі бази даних, яку представимо у вигляді таких діаграм: концептуальна модель, датологічна модель та фізична модель. Першим кроком є побудова концептуального проєктування, яка описується за допомогою таблиці, що має назву «Атрибути сутностей» та «Зв'язок сутностей». Другим етапом є створення датологічної моделі на основі створених «Зв'язок сутностей», що має такі зовнішні ключі: норма, нечітка множина, лінгвістична змінна. Наступним етапом є представлення фізичної моделі, де як СУБД обрано Microsoft SQL Server і відповідно до неї вказані типи даних.*

Ключові слова: інформаційні технології; концептуальна модель; модель даних; фізична модель; DFD-діаграма; атрибути; сховища даних

Link to the publication

APA Tsiutsiura, Mykola, Kostyshyna, Nataliia, Yerukaiev, Andrii & Tyshchenko, Dmytro. (2022). Representation of comfort idicators by means of DFD-diagrams. *Management of Development of Complex Systems*, 49, 26–32, dx.doi.org\10.32347/2412-9933.2022.49.26-32.

ДСТУ Цюцюра М. І., Костишина Н. В., Єрукаєв А. В., Тищенко Д. О. Представлення показників комфортності за допомогою DFD-діаграми. *Управління розвитком складних систем.* Київ, 2022. № 49. С. 26 – 32, dx.doi.org\10.32347/2412-9933.2022.49.26-32.