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Adaptive Data Warehouse as the Technological Basis of the Banking Ecosystem

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ABSTRACT

New guidelines of omnichannel and ecosystem are emerging driven by modern digital transformation of the banking business. To improve customer experience of interaction with banking services more banks are switching to the omnichannel model. In this model, the customer is able to perform operations in a unified interface using any communication methods, and sees no difference in the processes between off-line and on-line operations. This requires changes in a bank's IT architecture, whose center is a bank data warehouse. The **aim** of this study is to show the possibility of developing a method for designing a banking data warehouse so that it can be easily adaptable for new business projects and tasks. The authors used the following research **methods**: analysis, logical modeling of the identified relationships. They developed an adaptive banking data warehouse designer in the environments of SAP PowerDesigner, StarUML, PL/SQL Developer. The article **tackles** the approach towards development of an adaptive model of a banking data warehouse, based on the principle of splitting data into components. It makes it possible to set the warehouse contours for specific business tasks, combine elements, and expand the structure of the banking data warehouse in the context of its integration with various external software objects. The article highlights the interaction between the components of the banking data warehouse and business tasks, the list of which can be expanded in the context of various bank projects. The article provides a detailed description of the basic set of components of the adaptive banking data warehouse model. This set may serve as the foundation for designing a banking data warehouse for a specific business task. The article provides the data model and attribute composition of the General Ledger component, the data model of the Plastic Cards, Transactions, Applications, Contractors, etc. components, as well as indicates the relationships between the components. The study presents design features of a new type of the banking data warehouse. The authors concentrate on the technological features of creating a unified front-end omnichannel banking system as a separate task. They **conclude** that the developed basic set of components and business objects of adaptive banking data warehouse will ensure data integrity and reduce design time.
Keywords: client path; bank; omnichannel; ecosystem; data warehouse; design; methodology; information systems; digital services

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INTRODUCTION

Information management, processing of large data flows and integration with many software products are critical tasks for the banking sector. In terms of the transition to new digital business models, banks should pay special attention to predictive analytics, be able to make quick decisions to launch new products and have a flexible project management environment. Currently, in the context of digitalization and the transition to digital service channels, new guidelines are emerging to extract additional value from data. In this regard, a unified data warehouse can objectively give the bank a lot.

Moreover, the change in management paradigms also affects bank activities. Today, the bank is not just a digital or IT company. It can strengthen its position in the global business system and become an ecosystem for its customers. Today, such evolution of digital ecosystems is called Black ocean strategy [1]. This strategy combines a number of digital offers under one brand, which makes it impossible for competitors to seize the initiative in meeting the customer's need. Moreover, this need is studied in detail throughout the entire route: the need to receive a service — payment — a positive impression of the service and brand.

The trend for creating an ecosystem in business first appeared more than 20 years ago and was successfully implemented in the strategies of IT and service companies[1].

A strong bank is able to accompany the customer throughout his/her life, "navigate users through their daily digital journey"[2] so that s/he does not need to switch from a bank offer to a product of another company. The bank can monetize the extensive information about its customers by providing a wide range of products.

Information support of such diverse business processes and business tasks expands the requirements to the methodology for designing data warehouses (DWs), which is becoming a key technological basis of the banking ecosystem.

BANKING ECOSYSTEM PLATFORMS

The new network economy is a unified customer-centric ecosystem with three orbits of thinking around the customer. They interact clearly and determine the company's strategy: market position, change in business processes, and reaction to innovations. Today, banks are creating ecosystems, going beyond IT and fintech startups, actively implementing their own projects in healthcare, education, retail and, partially, transport. To some extent, aimed at increasing competition in the payment services market, adopted by the EU new directive on payment services PSD2 gave rise to banks for evolving into the ecosystem. It affected banks to provide open access to the API (Application Programming Interface is the interface that allows developers to create their own programs, applications, scripts

[1] Going digital: The banking transformation road map. A.T. Kearney & Efma. 2014.

[2] Ecosystem of ecosystems: an overview of Mail.ru Group's strategy. URL: https://corp.mail.ru/ru/company/strategy_ceo/?fbclid=IwAR1baqZoMkJKGhGH8_bqlU6–9kwhszoxdRTf-fAqiFZvu3B-WCOAdsu_LR3A (accessed on 28.02.2020).

for working with the service[3]). Open banking not only updated the banking technological infrastructure, but also intensified competition. To keep meeting market requirements and customer expectations as new steps, banks choose to build a common ecosystem (lifestyle banking), where one mobile banking application can cover almost 100% of the customer's potential needs in any area of life — from buying products to acquiring housing, from selecting and paying for training courses to ordering food.

The leading companies aim to improve the experience for their customers not only in their field, but also throughout their entire life path. Therefore, their new offers refer to human experience and needs outside of specialized services.

In the Russian banking industry, Alfa-Bank, Tinkoff Bank, VTB Bank (PJSC) and other banks introduce the ecosystem paradigm. PJSC Sberbank adopted an implementation strategy to be transformed into a universal technology company by 2020. In December 2018, it established SberX Ecosystem Development Department[4]. This ecosystem includes over 20 different companies. Today, PJSC Sberbank sells coffee in its branches, provides food delivery together with Mail.Ru, gathers vacancies together with Rabota.ru, provides access to telemedicine together with DocDoc, conducts online trading together with Yandex. Market (Yandex.Market, marketplaces Beru! and Bringly), provides services for the sale of apartments together with DomCklik. In 2020, in the Moscow branch of Sberbank near the Novoslobodskaya metro station, they opened McCafe areas with a tablet on the wall, so that the customer could order from the McDonald's standard menu and order food delivery to the department. Today, the advanced bank has integrated itself into the value chain in many segments. In exchange, the partners gained access to customer data. The introduction of new technologies supports the ecosystem's IT functionality, including through identification services, fast data exchange, etc. The ecosystem has open interfaces or provides compatibility: convenience, security. Unified software interfaces make it easy to connect to the platform.

The primary goal of the bank's ecosystem is to provide omnichannel services, where many channels of communication support the creation of a seamless client path. The transition to omnichannel poses many challenges (*Fig. 1*). The transition to omnichannel brings its own adjustments to management, IT architecture, corporate culture, etc. [2].

To switch to the omnichannel model, the bank is expanding its portfolio of software services. Thus, PJSC Sberbank acquired services that made a name in the market and introduced into its brand, and launched the SberCloud cloud platform. JSC Tinkoff Bank creates its own services and integrates third-party ones, and offers customers more than 120 affiliate programs[5]. It also contributes to changing the technological platform.

ARCHITECTURAL CONCEPT OF CREATING A UNIFIED FRONT-END OMNICHANNEL BANKING SYSTEM

In the context of omnichannel, the bank creates various options. The customer is given the opportunity to make transactions on the website, via the mobile application, etc., the contact history is saved in all points of access to the bank, new data is collected, and feedback is provided based on heterogeneous information from various sources. At the same time, the customer does not feel the difference between the service channels, whether it is the bank's office or its mobile application. The truth is that creating several channels and integrating them is not enough. Blurring the distinction between the processes of various channels requires implementing the prin-

[3] What is the Yandex.Direct API? URL: https://yandex.ru/dev/direct/doc/start/intro-docpage/ (accessed on 20.02.2020).

[4] Sberbank replaced the head of its SberX ecosystem. URL: https://www.vedomosti.ru/finance/news/2019/07/03/805704-sberbank-smenil-rukovoditelya-ekosistemi (accessed on 28.02.2020).

[5] Going digital: The banking transformation road map. A.T. Kearney & Efma. 2014.

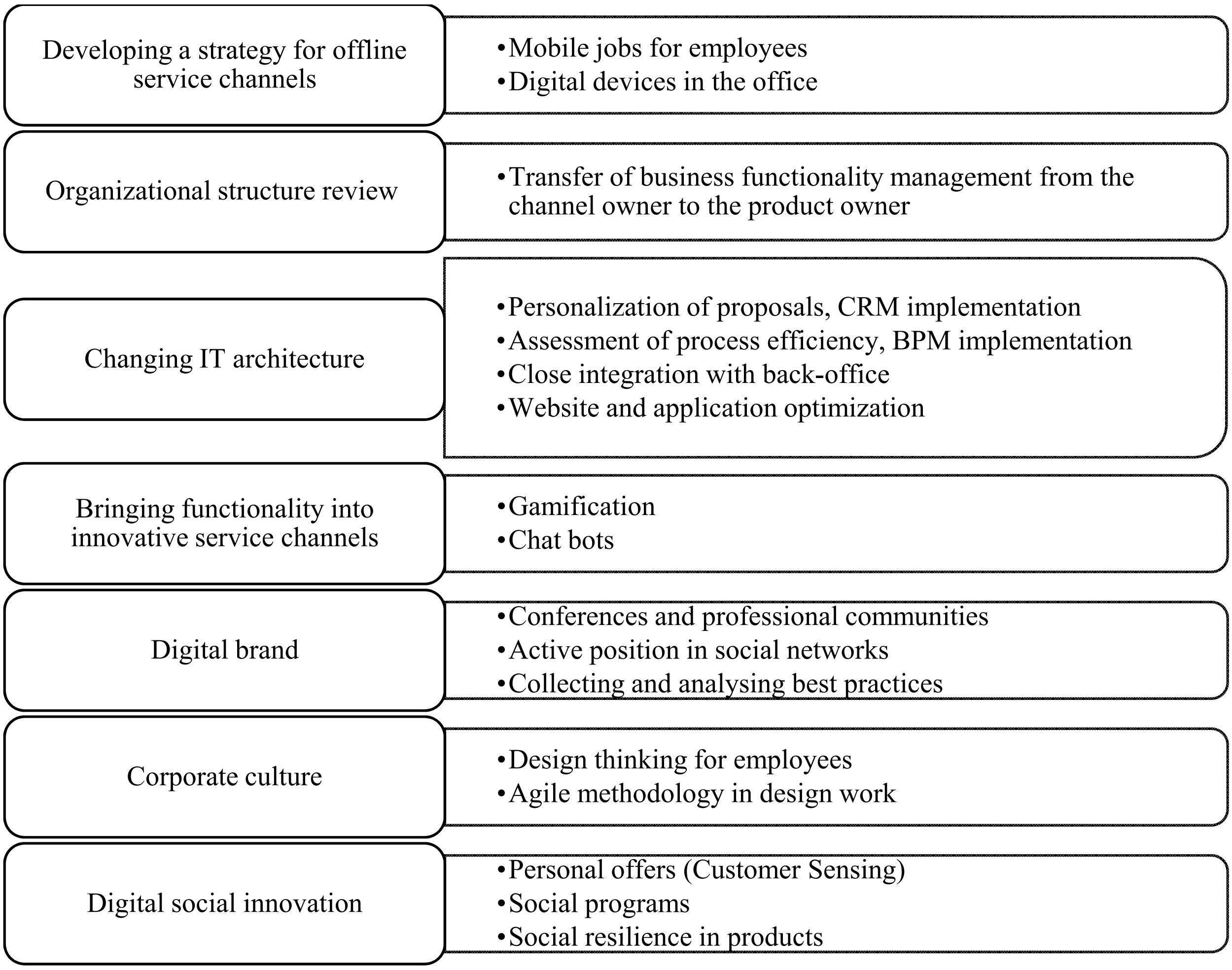

Fig. 1. **Key strategic objectives to transform customer experience based on omnichannel**

Source: complied by the authors.

ciples of a unified business logic for providing services. Interaction with the customer is based on combining front and back offices, all bank processes, and updating the entire service model.

Moving from multichannel to omnichannel in a large bank is a long process of implementing many projects. Processes should be optimized and internal regulatory documents, regulations, technological schemes and work methodology changed. All local front-end systems must be decommissioned, and the functionality must be transferred to the target unified front-end system. All local back-office systems must be integrated into a unified back-office system consisting of flexible customizable applications. The departments of security, quality, and operational risks should strengthen the technologies used and automated systems.

The technological basis of banking is BaaS multi-component platform (Banking-as-a-Service)[6]. In this case, complicated banking applications exist as web services. From the perspective of IT architecture, this means moving from monolithic independent systems, each servicing a limited number of channels, implementing its own business logic and set of services, to a unified front-end application architecture. It shows the service model, provides an optimal user interface considering the characteristics of the channel, and relies on a unified business node of the entire network.

[6] Going digital: The banking transformation road map. A.T. Kearney & Efma. 2014.

Implementing omnichannel requires **a unified business logic of operations**. Each operation is automated as a business process including:

- calling channel-dependent subprocesses or services (if this is implemented, for example, for the subprocesses of identification, credit processing, opening a deposit or transfers);
- calling a specific subprocess using a channel-independent representation of the application. Payment process is an example of such a subprocess. This subprocess assumes the existence of a unique search operation for a service provider to which the funds will be transferred. At the same time, the search for the service provider does not depend on where the payment was initiated: in the mobile application or in the browser version of the online bank.

All business processes with a common business task, but different in implementation depending on the channel, must have a common channel-independent API. All processes associated with filling an application with the content attribute (a set of specific characteristics) should be based on a unified application class for all channels. The process of performing an operation with the possibility of starting and ending the operation in different channels must meet the requirements, depending on whether the process stops and/or resumes on the channel.

A key step towards moving the bank to omnichannel is the step from monolithic independent systems with a limited number of channels that implement their own business logic and a set of services, to a unified architecture of front-end applications in the system. Following the basic architectural development principles allows for creating reusable services in different channels. The rational approach to changes enables banks to avoid mistakes typical of the multi-channel strategy: with a huge number of applications, either completely closed for updates, or unreasonably high costs for updates.

The omnichannel project should focus on introducing design thinking [1–5] and product management approaches in the Lean StartUp principles [6–8]. When implementing front-end solutions, it is necessary to iteratively approach the layout development of user interfaces, apply the tools and methods of design thinking, usability testing. Besides, it is important to analyze customer behavior and optimize business functionality, determine the reasons for customer requests and terminating operations. It is important to understand that the customer's actions are his/her voice. Thus, along with technological integration of channels, there should also be a new mental service strategy.

When implementing the omnichannel approach, we also solve convenience and well-functioning issues of digital channels, and preserve the possibility of personal communication with the customer [9–13].

THE ROLE OF THE DATA WAREHOUSE IN THE DEVELOPMENT OF BANKING BUSINESS IN THE AGE OF DIGITAL TRANSFORMATION

Today, the classical definition of data warehouse by B. Inmon [14] as a "subject-oriented collection of data" may be expanded to consider business-specific guidelines. The main purpose of the data warehouse associated with reporting and business analysis in the organization is supplemented by advanced functions for ensuring customer-oriented and personalized offers, covering customer needs at 360 degrees, interacting with partners in a large pool of tasks, including beyond the usual areas of the bank's activity, flexible transformation of existing product lines and introducing new ones.

A limiting factor in the banking sector development may be the underestimation of the capabilities of the data warehouse design technology. The data warehouse should be an integrated (unified) collection of data with centralized management [15], should meet the needs of all the company's departments on the principle of "source once, distribute many times" [16] and solve the problem of collecting and processing data from hetero-

Strategic development and operations management	Planning and monitoring key performance indicators, KPI
	Cost-effectiveness analysis and business process optimisation
Corporate and retail unit management	Assessment of profitability of banking products, customers and distribution channels
	Customer profitability and performance analysis
Financial management	Budgeting and management reporting for the bank, branches and divisions
	Regulatory reporting, preparation of tax returns and IFRS reporting
Marketing	Evaluation of the effectiveness of product policies, marketing costs
	Flexible pricing
Product management	Personalization and targeting of an offer
	Omnichannel services

Fig. 2. **Data warehouse functions in business process management tasks of a bank**
Source: complied by the authors.

geneous sources, supporting the entire IT architecture of the bank.

Fig. 2 presents data warehouse functions that can support business processes at different levels of the organization.

Adaptive banking data warehouse concept

The concept of an adaptive banking data warehouse model is based on the following principles and features: the ability to quickly configure for business tasks, scalability, omnitude, complexity, target level of abstraction.

The business-oriented approach is based on the GRAnD methodology (goal-oriented approach to requirement analysis in data warehouses), which allows designing a data warehouse considering the needs and characteristics of the organization [17, 18]. The growth needs of information support require efforts to review the model and, if necessary, update the banking data warehouse (BDW) in terms of its adaptation to specific tasks. This process can be simplified by designing a universal data warehouse model that can be adapted to new business goals, thereby becoming the basis for the design of *an adaptive banking data warehouse*. Development based on previously created components that are modified to meet new requirements is a frequent technique in creating software products [19, p. 40]. First, the basic set of tasks is compiled, by which new business requirements, technical requirements for the data warehouse are developed and formalized, and then they are implemented in accordance with the selected reference model.

A banking data warehouse model must also be scalable to enable designers to grow storage as they expand their task list. It is important that increasing number of tasks and the data warehouse lead to a change in hardware requirements and a revision of the hardware and software configuration.

The adaptive banking data warehouse model describes the key elements of the banking subject area and contains a basic set of components and business objects. Componentwise system development with adaptation to new requirements has been used in software development since the late 1990s. Studies [19–22] are devoted to the possibilities of reusing components. I. Sommerville stated that generic models do not so accurately describe an object or process as they represent "useful abstractions that help apply various approaches and technologies to the development process" [19].

B. Meyer proposed the classification [20], where the components of the adaptive banking data warehouse belong to the level of system abstraction and can be applied in various modifications.

Work [21] developed the idea of generic patterns by S. Alexander [22]. E. Gamma, R. Helm, R. Johnson and J. Vlissides call the design pattern a design solution template that can be changed in different situations of the problem area. I. Sommerville notes that such a multicomponent approach allows reducing development costs and speeding up the design process itself [19].

The basic set of components of the adaptive banking data warehouse was based on expert opinion. The group of experts took part in selecting the component set, which included representatives of the business departments of two banks, the end users of the data warehouse, specialists of bank IT departments responsible for data management, as well as employees of the integrator company that implements the data warehouse in banks. The examination procedure was based on the Delphi methods, normalized rank [23], and index grouping. To assess the consistency of expert opinions, the dispersion coefficient of concordance was calculated, and its statistical significance was evaluated.

The adaptive warehouse architecture implies possible expanding the data model for

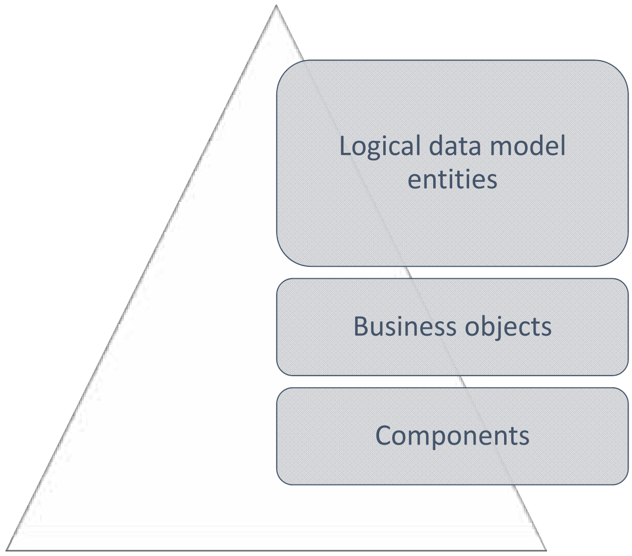

Fig. 3. **Architecture of the adaptive model of a banking data warehouse**

Source: complied by the authors.

a specific request. The adaptive banking data warehouse architecture is a three-level structure of elements that allow describing the subject area at various levels of abstraction (*Fig. 3*).

At the lower level of the architecture are the components of the adaptive banking data warehouse — a set of business objects that have semantic connections and a similar data structure. At the next level, each component is detailed to the level of business objects that correspond to any participant in one or more business processes of the organization. At the top level of the architecture, an area has been allocated for detailing each business object to the set of entities of the logical data model.

All credit organizations have common features: they have similar business processes, goals, objectives, information flows, etc. A business object at the top level of architecture is one or more required entities and an unlimited number of additional entities.

The next level reflects the features associated with the policies of a particular organization, market position, information systems used and a number of other reasons. Therefore, at each level, the degree of abstraction decreases, the entities are typified. The data description is concretized in a universal logi-

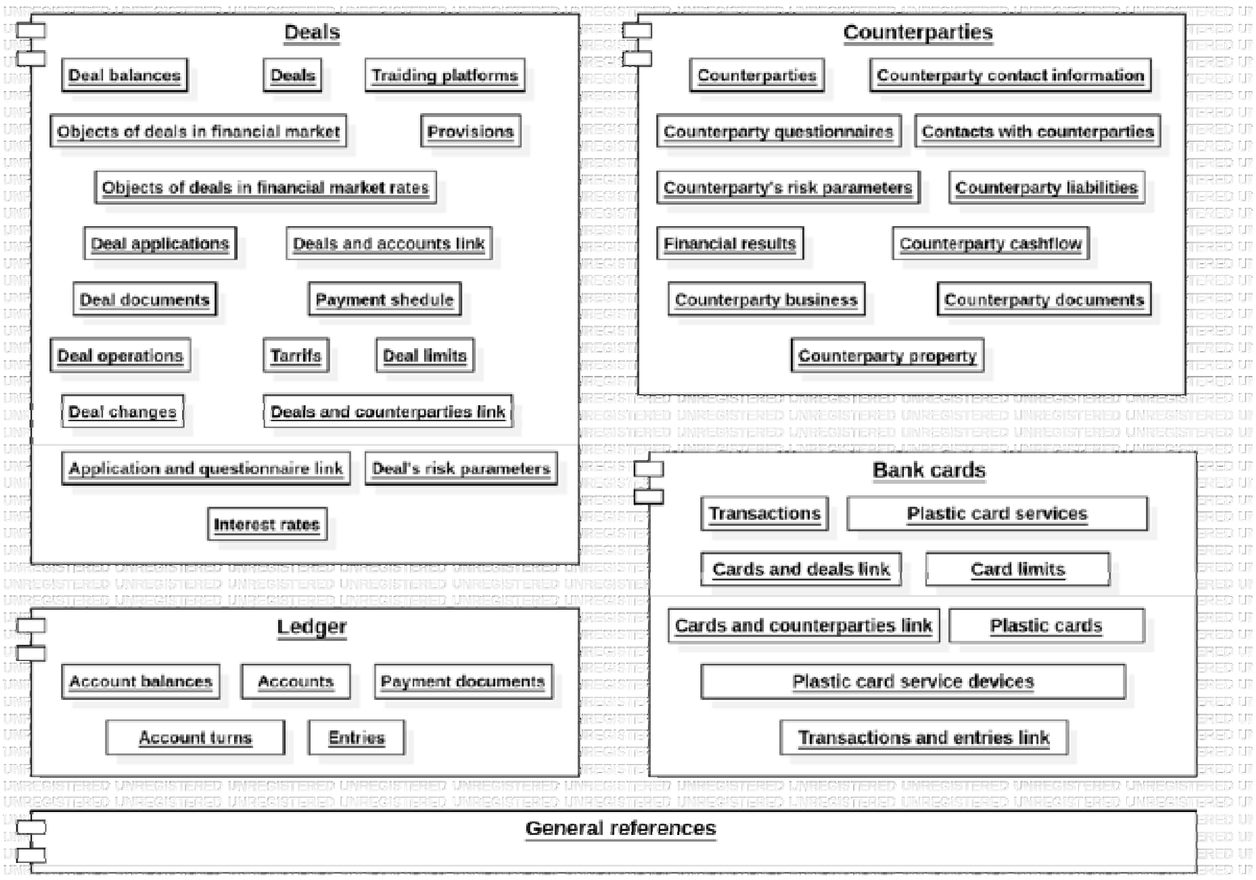

Fig. 4. **Basic set of components and business objects**

Source: developed by the authors.

cal model, adapting to the needs of new projects. Using components allows for reducing labor costs for design and improving the quality of the final system.

Fig. 4 presents the basic set of components and business objects of the adaptive model of a banking data warehouse and business objects, which can be used as the basis for designing a banking data warehouse for a specific business task.

Logical data model entities describe a business object. The key entity is the *main table*, which contains the basic attributes characterizing the business object. The main ones can be tables "Deal", "Counterparty", "Account", etc. A standard table is an entity that contains additional information about business object instances that have the same type in the main table. It contains additional attributes typical for this type of object. For example, standard entities are the "Credit deal" and "Deposit deal" (in this example, the main table is the "Deal" entity). The third type of entity of this data model is *a bridge table*, necessary for implementing many-to-many relationships between other entities. Bridge tables can be used:

- to link two business objects (including different components), for example, "Deal and accounts link";
- to link instances of one entity, including to present the hierarchy of objects, for example, "Deals link".

Some attributes of business objects may change over time, for example, attributes of the deal status or counterparty rating. Special entities of the "*Version Attribute Table*" type are created for them in the model.

In some cases, highly specialized information about some objects should be stored in data warehouses. This kind of information, as a rule, represents one or more attributes assigned to few instances of business objects. To do this and to avoid high sparse data, entities

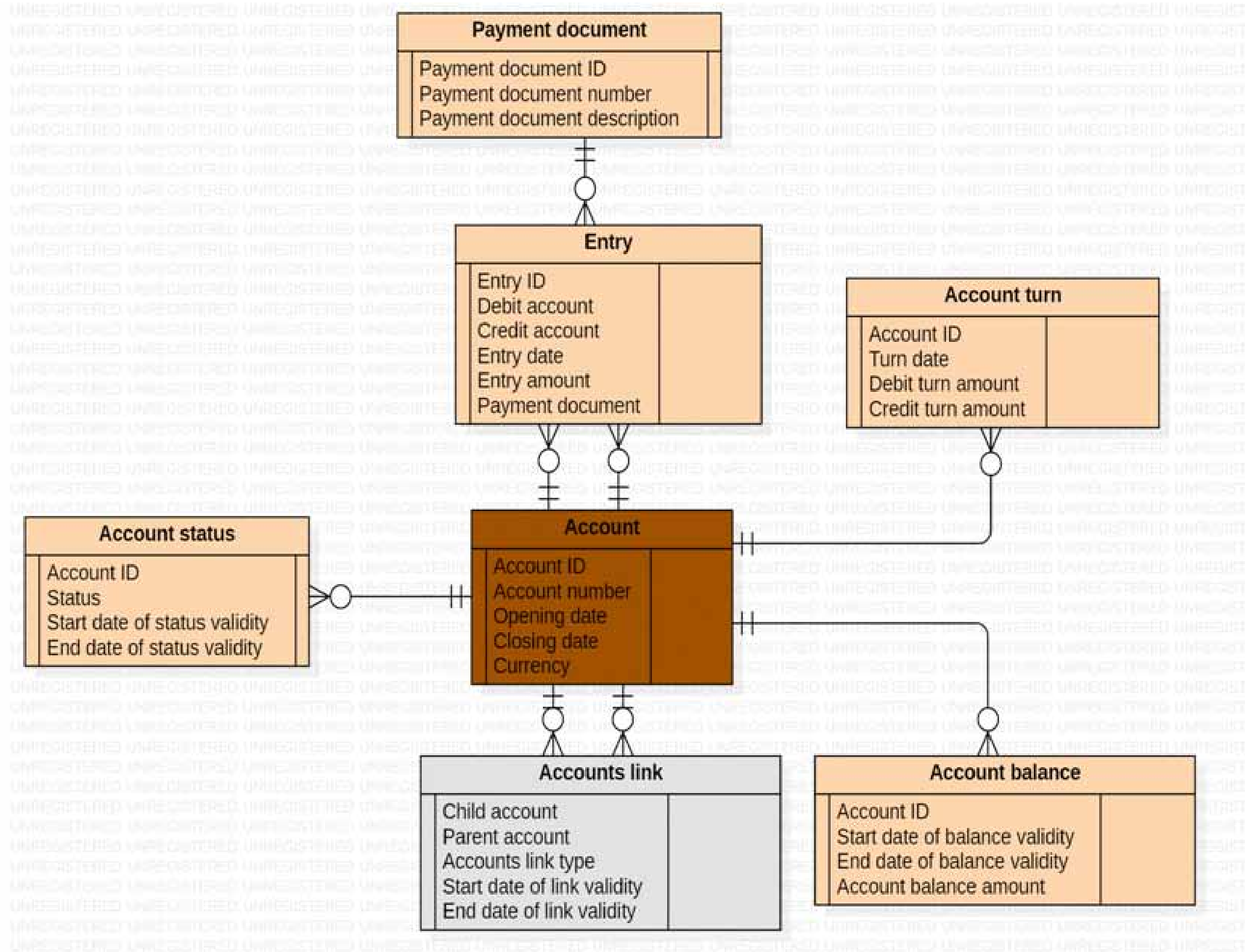

Fig. 5. **General Ledger component (subpicture)**

Source: developed by the authors.

of the "*Additional attributes table*" type are created in the model. Just as a mandatory set of tables is provided for any type of business object, a set of required attributes (attribute composition) is provided for each type of table.

Here is a description of some of the basic components of the adaptive banking data warehouse. The list of basic components of the adaptive banking data warehouse is based on key business processes implemented in banks, as well as standard banking services.

Fig. 5 illustrates the data model of the General Ledger component of the adaptive banking data warehouse model.

The General Ledger contains information about all bank accounts, their main details and factual information:

- entries are atomic banking transactions that involve flow of funds from one account (credit account) to another account (debit account);
- the payment document is the document that generated the entry; it contains detailed information about the purpose of the entry, turnovers;
- the account turn in the business sense is the aggregation of entries of the account within one banking day (respectively, for credit and debit of the account);
- the account balance is the amount of all the account turns at any moment of time (usually at the end of the banking day).

Some accounts may be linked to each other, for example, a relationship between an asset's account and a reserve account of this asset. Accounts can have various statuses: open, closed, arrested, blocked, etc. *The table* below presents the basic attributes of the tables in the General Ledger component.

The Deals component contains entities similar to the composition of the General Ledger, but related to deals (contracts). These are, for example, the "Deal relationship", "Deal status" and "Deal balance" entities. Besides, the Deals component include specific entities. Such an entity is "Deal maturity", which contains information about the contract validity and planned closing date. The deal maturity may change, for example, due to the prolongation (in the case of deposits). Deals typically have different interest rates (for example, for credits): the main interest on the principal debt; on overdue principal debt; for unpaid commission amount, etc.

Important information is transactions that may correspond to an entry, may be associated with several entries or may not be associated with entries at all, for example, when changing the type of transaction balance within one bank account. Besides, the Deals (base) component includes information on schedules and tariffs.

Credits are a very specific type of banking deals. In turn, they can also be divided into fundamentally different subtypes: one-time loans and credit lines. An important feature of credits is the need to reserve them, i.e. the bank must create provision for reserves in case of non-return of previously issued funds. Depending on various factors, a loan can be reserved individually or in a portfolio. A provisioning portfolio is a portfolio of homogeneous loans grouped by a similar debt structure. There are collaterals for many loans. The collateral may be the lending object itself (for example, a car or real estate), securities, a guarantee agreement, etc. A credit deal may be restructured in the event of a change in the payment schedule, currency change, etc. In case of problems with collecting debts from the borrower, the bank may require borrowed funds through the court. Decisions made in court are also uploaded to the credit institution's information system.

Fig. 6 shows the data model of the Plastic cards component (a subpicture is presented for credit cards). Deals with plastic cards have

Table

Attribute composition of the entities of the General Ledger component (fragment)

Entity	Attribute
Account	Account ID
Account	Account number
Account	Opening date
Account	Closing date
Account	Currency
Accounts link	Child account
Accounts link	Parent account
Accounts link	Accounts link type
Accounts link	Start date of link validity
Accounts link	End date of link validity
Account turn	Account ID
Account turn	Turn date
Account turn	Debit turn amount
Account turn	Credit turn amount
Account status	Account ID
Account status	Status
Account status	Start date of status validity
Account status	End date of status validity
Entry	Entry ID
Entry	Debit account
Entry	Credit account
Entry	Entry date
Entry	Entry amount
Entry	Payment document
Payment document	Payment document ID
Payment document	Payment document number
Payment document	Payment document description

Source: developed by the authors.

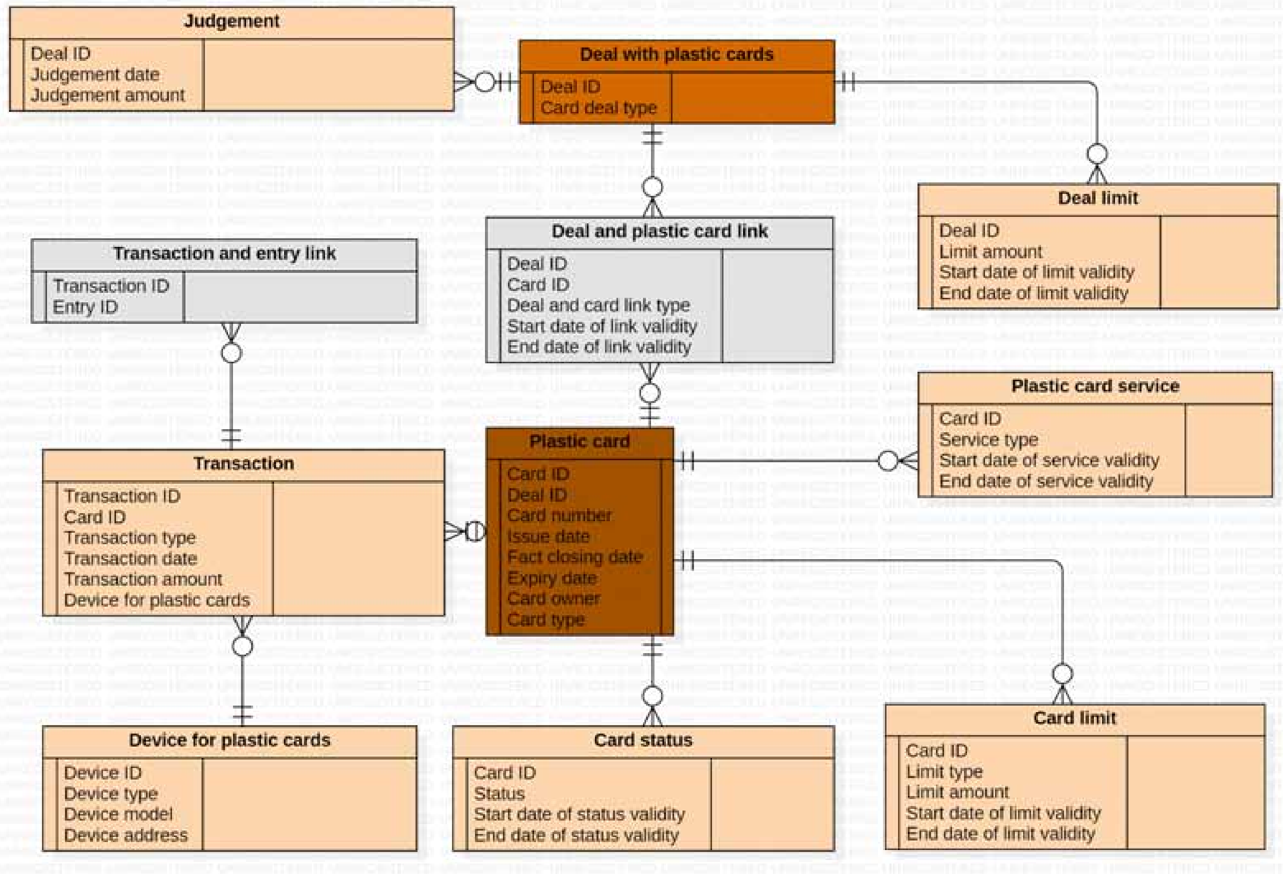

Fig. 6. **Plastic cards component (subpicture)**

Source: developed by the authors.

their own features. First, several plastic cards can be linked with the same agreement: one main and many additional ones. All cash accounting is carried out under the contract, and there is a credit limit, i. e. how much money a customer can get on credit. For the plastic card, as well as for the deal, the limit is set by the customer as part of the deal limit, and the status. Plastic cards are characterized by transactions — similar to deals, but with the specifics of accounting in the processing system.

The Applications component is small in the number of entities, but very rich in the attributes in applications and customer profiles (both existing and potential).

The Counterparties component is very extensive, but clear in business sense, since it does not contain information specific to the banking sector. It stores all information about the customers available to the bank (both from internal and external sources). This component is crucial in solving problems of segmenting the customer base, scoring, etc.

The Deals in the financial market appear as a separate component of the model for two main reasons: the relatively rare need of the bank for such information in the data warehouse and a sufficiently large number of attributes that characterize various objects of such deals. Note that if there is no need to implement the "Security" entity and its subsidiaries, tables "Currency" and "Quotation of object of deal" should be implemented as part of the Deals (base) component, since in any case information about exchange rates is needed to convert funds on accounts and deals in various currencies.

Despite the relative unitarity of the model components, they are interconnected:

- the General Ledger is linked with the Deals (base) component by the "Deals and accounts link" and "Deal and entry link" bridge entities;

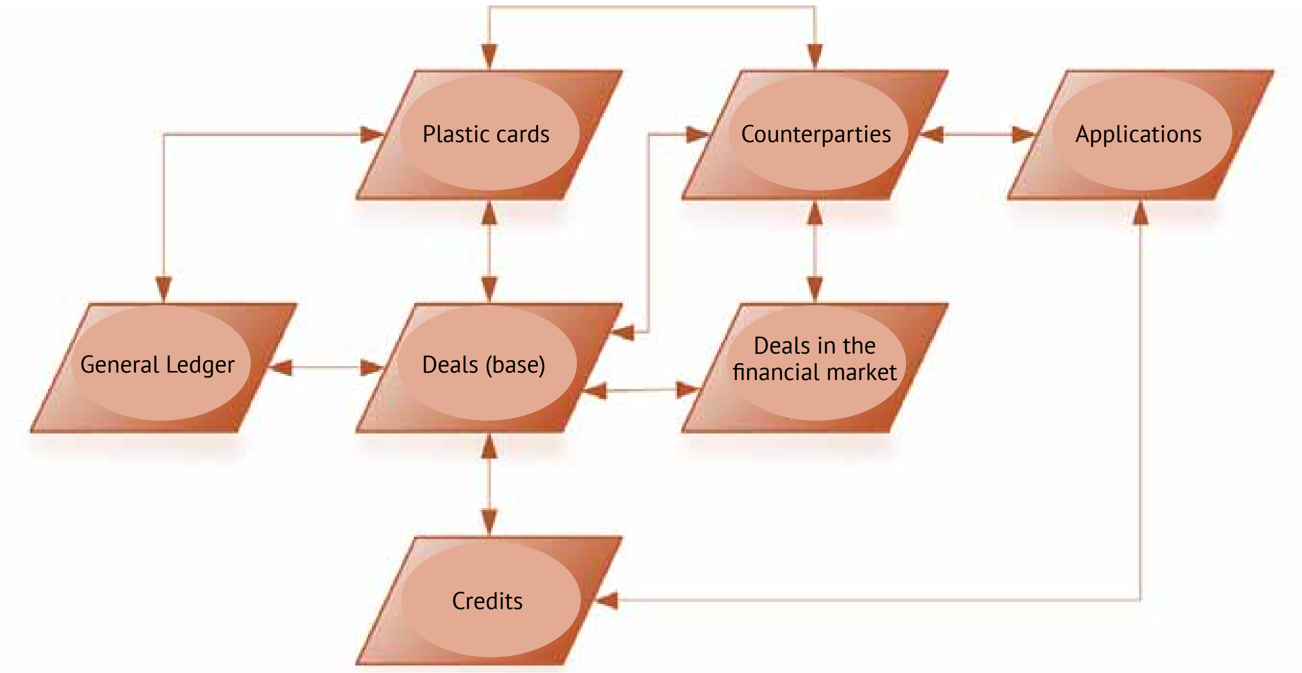

Fig. 7. **Interaction between the components of the reference model of a banking data warehouse**

Source: developed by the authors.

- the General Ledger is linked with the Plastic cards component by the "Deal and entry link" bridge entity;
- the "Credit deal" entity of the Credits component is a child entity with respect to the "Deal" entity of the Deals (base) component i.e. the Credits and Deals (base) components have a one-to-one relationship in the "Deal ID" field;
- the "Plastic card deal" entity of the Plastic cards component is a child of the "Deal" entity of the Deals (base) component, i.e. the Plastic cards and Deals (base) components have a one-to-one relationship in the "Deal ID" field;
- the "Deal in the financial market" entity of the Deals in the financial market component is a child of the "Deal" entity of the Deals (base) component, i.e. the Deals in the financial market and Deals (base) components have a one-to-one relationship in the "Deal ID" field;
- the "Credit deal" entity of the Credits component is linked with the "Application" entity of the Applications component by the "Deal ID" attribute;
- the Deals (base) is linked with the Counterparties component by the "Deal and counterparties link" bridge entity;
- the "Questionnaire" entity of the Applications component is linked with the "Counterparty" entity of the Counterparties component by the "Counterparty ID" attribute;
- the "Plastic card" entity of the Plastic cards component is linked with the "Counterparty" entity of the Counterparties component by the "Counterparty cardholder" attribute;
- the "Security" entity of the Deals in the financial market component is linked with the "Legal entity" entity of the "Counterparties" component by the "Counterparty issuer" attribute.

Thus, the interaction between the components of the adaptive model of a banking data warehouse can be represented by a diagram *(Fig. 7)*.

To generate financial statements and manage the liquidity of a credit institution, it is sufficient to implement the basic component of the reference model, the General Ledger, in the data warehouse. Solving other problems will require implementing the remaining components of the model. The Deals (base) and Counterparties components are necessary to solve the vast majority of the business tasks. The Deals in the financial market and

Applications, on the contrary, are required in a relatively small number of business cases. For this reason, many credit organizations are able to optimize their costs to build a data warehouse by abandoning these components. The task of managing bank risks is extremely complex and large-scale. Solving this kind of problems requires an end-to-end analysis of almost all business processes of the bank; therefore, if a credit institution intends to manage risks using a data warehouse, it will have to implement all the proposed components of the model.

Adaptive banking data warehouse design technique: key steps

The sequence of actions aimed at moving from a high-level business description of a problem to a formalized data model and architecture of applied systems can be as follows:

1. Verbal high-level description of automated business processes.
2. Classification and grouping of business processes in order to identify areas of activity.
3. Highlighting common fragments of business processes, key participants, key accounting objects and data flows.
4. Determination of the necessary warehouse components from the basic set of the adaptive banking data warehouse.
5. Selection of the required business objects from the basic set of the adaptive banking data warehouse and their enrichment for the particular organization in accordance with its architecture.
6. Detailing business objects to entities of a logical model, establishing relationships between them, developing an ER-model.
7. Filling manual reference business objects.
8. Development of a functional architecture of applied systems.

CONCLUSIONS

The current situation in the banking services market requires new technological solutions. Banks are expanding the range of offers, offering customers new products and services. Customers expect interaction primarily through digital channels. High competition with fintech companies makes banks to become fully digital. A fully digital organization is built on digital technology.

One of the most effective solutions to solve the problem of a quick transition to new business models and to implement new areas of activity is data warehouses. The implementation of analytical systems in banks is carried out through solving a number of business problems. However, the fundamental task of data warehouses is to consolidate all information available in the company, unify and verify it, as well as to integrate existing information systems into requests for data sources.

The study formulates the basic principles and characteristics of the adaptive banking data warehouse model. The paper presents the architecture of the banking data warehouse, which may consist of many components and be configured for various tasks. In a model of this type, each level describes the subject area and the associated data flows with varying degrees of detail and abstraction. The article provides the basic set of components and business objects of the adaptive banking data warehouse, covering a significant part of the typical business needs of credit organizations.

To provide omnichannel and 360-degree customer service, the bank's IT architecture must be very flexible and scalable. In particular, such requirements are imposed on the data warehouse as a key element of this architecture. Applying the component approach to designing DWs, in particular, will allow us to solve this problem, i.e. to increase not only the volume of stored data, but also the reach of supported business processes. Simplifying the DW design process increases the development of the bank's IT architecture in terms of information provision and makes it possible to build an ecosystem that meets all requirements of the modern customer.

REFERENCES

1. Lewrick M., Link P., Leifer L. The design thinking playbook: Mindful digital transformation of teams, products, services, businesses and ecosystems. Hoboken, NJ: John Wiley & Sons; 2018. 352 p. (Russ. ed.: Lewrick M., Link P., Leifer L. Dizain-myshlenie. Ot insaita k novym produktam i rynkam. St. Petersburg: Piter; 320 p.).
2. Going digital: The banking transformation road map. A.T. Kearney & Efma. 2014.
3. Vasil'eva E.V. Design thinking: A little bit about the approach and a lot about the tools for creative thinking, studying client requests and creating ideas. Moscow: RuScience; 2019. 204 p. (In Russ.).
4. Brown T. Change by design: How design thinking transforms organizations and inspires innovation. New York: HarperCollins Publishers; 2009. 272 p.
5. Kelley T., Kelley D. Creative confidence: Unleashing the creative potential within us all. New York: Barnes & Noble; 2013. 304 p.
6. Liedtka J., Ogilvie T. Designing for growth: A design thinking toolkit for managers. New York, Chichester: Columbia University Press; 2011. 248 p.
7. Clark T., Osterwalder A., Pigneur Y. Business model you: A one-page method for reinventing your career. New York: John Wiley & Sons; 2012. 256 p.
8. Ries E. The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. New York: Crown Business; 2013. 336 p.
9. Blank S. The four steps to the epiphany: Successful strategies for products that win. Berks County: K & S Ranch; 2014. 276 p.
10. Goldhill J. The age of omnichannel banking. Transform. URL: http://www.transformuk.com/wp-content/uploads/2015/03/Transform-UK-The-Age-of-Omnichannel-Banking-Report.pdf (accessed on 10.02.2020).
11. Karpuzcu T. Impact of e-services on customer satisfaction. Saarbrücken: LAP Lambert Academic Publishing; 2011. 124 p.
12. Ramadan S. Omnichannel marketing: The roadmap to create and implement omnichannel strategy for your business. Charleston, SC: CreateSpace Independent Publ. Platform; 2016. 66 p.
13. Malhotra J.S. Multi-channel optical communication. Saarbrücken: Scholars' Press; 2014. 220 p.
14. Skinner C. Digital bank: Strategies to launch or become a digital bank. Singapore: Marshall Cavendish Int. (Asia) Pte Ltd.; 2014. 300 p. (Russ. ed.: Skinner C. Tsifrovoy bank. Kak sozdat' tsifrovoy bank ili stat' im. Moscow: Mann, Ivanov and Ferber; 2014. 320 p.).
15. Inmon W.H. Building the data warehouse. New York: John Wiley & Sons Inc.; 2002. 428 p.
16. Poppendick M., Poppendieck T. Implementing lean software development: From concept to cash. Upper Saddle River, NJ: Addison-Wesley; 2006. 304 p. (Russ. ed.: Poppendick M., Poppendieck T. Berezhlivoe proizvodstvo programmnogo obespecheniya: ot idei do pribyli. Moscow: Williams; 2010. 256 p.).
17. Giorgini P., Rizzi S., Garzetti M. GRAnD: A goal-oriented approach to requirement analysis in data warehouses. *Decision Support Systems.* 2008;45(1):4–21. DOI: 10.1016/j.dss.2006.12.001
18. King B. Breaking banks: The innovators, rogues, and strategists rebooting banking. Singapore: John Wiley & Sons; 2014. 288 p.
19. Arican A. Multichannel marketing: Metrics and methods for on and offline success. Indianapolis, IN: Wiley Publishing; 2008. 312 p.
20. Sommerville I. Software engineering. 6th ed. Reading, MA: Addison-Wesley; 2000. 720 p. (Russ. ed.: Sommerville I. Inzheneriya programmnogo obespecheniya. Moscow: Williams; 2002. 624 p.).
21. Meyer B. On to components. *Computer.* 1999;32(1):139–143. DOI: 10.1109/2.738312
22. Gamma E., Helm R., Johnson R., Vlissides J. Design patterns: Elements of reusable object-oriented software. Reading, MA: Addison-Wesley Professional; 1994. 395 p. (Russ. ed.: Gamma E., Helm R., Johnson R., Vlissides J. Priemy ob"ektno-orientirovannogo proektirovaniya. Patterny proektirovaniya. St. Petersburg: Piter; 2001. 368 p.).
23. Alexander C, Ishikawa S. at al. A pattern language: Towns, buildings, construction. New York: Oxford University Press; 1977. 1171 p. (Center for Environmental Structure Series. Vol. 2).
24. Evlanov L.G., Kutuzov V.A. Expert evaluation in management. Moscow: Ekonomika; 1978. 133 p. (In Russ.).

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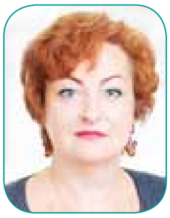

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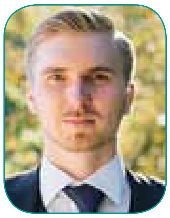

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Vasilieva E.V.— problem definition, concept formation of the study; review of current trends, description of the results, conclusions.
Solyanov K.S.— concept of adaptive banking data warehouse, development and implementation of a basic set of components and business objects of the adaptive banking data warehouse model, graphical representation of the results.
Konevtseva T.D.— architectural principles for creating a unified front-end omnichannel banking system.

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