Methods of Information Resources Processing in Virtual Library

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Abstract. The thesis discusses the development of unified methods and software tools for processing information resources in Virtual Library as example the electronic content commerce systems (ECCS). A model of Virtual Library Systems (VLS) is proposed. The models of information resource processing in ECCS are proposed. Architecture and models of VLS are built. A new approach to application and implementation of business processes is formulated for the construction of VLS. A complex method of content creation, the operational method of content management and complex method of content support are developed. Design and implementation methods of VLS are based on online newspapers, which reflect the results of theoretical research, are developed. From the perspective of a systemic approach, the principles of applying information resources processing in electronic content commerce systems for content lifecycle implementation made the development of methods for the content formation, management and support possible. An integrated method of content formation for the time and resources reduction of content production is developed. A method of content management for the time and resources reduction of content sales was created, which makes it possible to implement content management subsystem. A method of content support for the time and resource reduction of the target audience analysis in VLS is implemented, which makes it possible to develop a content support subsystem.

Keywords: content, commercial content, information resource, business-process, content management system, content lifecycle, Internetnewspaper, electronic content commerce system, Virtual Library.

1 Introduction

Rapid development of the Internet contributes to the increase of needs for the efficient data of the production / strategic nature and implementation of new forms of information services through modern information technologies (IT) of e-commerce.

Documented information prepared in accordance with users needs is a commercial content. Today e-commerce is a reality and a promising business process. Internet is the business environment, and commercial content is a commodity with the highest demand and selling rate. It is also the main object of the processes of electronic content commerce. Commercial content can be immediately ordered, paid and got on-line as a commodity. The entire spectrum of commercial content is sold via the Internet - scientific and publicistic articles, music, books, movies, pictures, software etc. Well-known corporations that implement electronic content commerce are Google through Google Play Market, Apple - Apple Store, Amazon - Amazon.com. Most of the decisions and researches are conducted at the level of specific projects. Systems of electronic content commerce (SECC) are built on the closed principleasnon-recurrent projects. Modern SECC are focused on the realization of commercial content that is made outside of the system. Design, development, implementation and maintenance of SECC are impossible without the use of modern methods and information technologies of formation, management and maintenance of commercial content.

2 Relevance of the paper

Development of the technology of information resources processing is important in view of such factors as lack of theoretical grounding of methods of study of commercial content flows and the need for unification of software processing methods of information resources in ECCS. A practical factor of the processing of information resources in VLS is related with the solution of problems of formation, management and support of growing volumes of commercial content in the Internet, rapid development of e-business, widely spreaded availability of the Internet, the expansion of the set of information products and services, and increasing of a demand for commercial content. Principles and IT of electronic content commerce are used while creating on-line stores (selling of e-Books, Software, video, music, movies, picture), on-line systems (newspapers, magazines, distance education, publishing) and off-line selling of content (copywriting services, Marketing Services Shop, RSS Subscription Extension), cloud storage and cloud computing. The world's leading producers of means of processing of information resources as Apple, Google, Intel, Microsoft, and Amazon are working in this area [2, 4-7].

A theoretical factor of information resources processing in ECCS is connected with the development of IT processing of commercial content. In scientific studies of D. Lande, V. Furashev, S. Braychevsky, A. Grigoriev mathematical models of electronic processing of information flows are investigated and developed [1, 10-11]. G. Zipf proposed an empirical law of distribution of word frequencies in natural language text content for its analysis. In the works of B. Boiko, S. McKeever, A. Rockley models of the life cycle of content are developed [1-21]. The methodology of content analysis for processing textual data sets was initiated and developed by M. Weber, J. Kaiser, B. Glaser, A. Strauss, H. Lasswell, O. Holsti, Ivanov, M. Soroka, A. Fedorchuk. In the works of V. Korneev, A. Gareev, S. Vasyutin, V. Reich were proposed methods of intellectual processing of text information. EMC, IBM,

Microsoft Alfresco, Open Text, Oracle and SAP have developed specification of Content Management Interoperability Services based on Web-services interface to ensure interoperability of electronic content commerce system management [4-7]. From the scientific point of view, this segment of IT is not investigated enough. Each individual project is implemented almost from the very beginning, in fact, based on the personal ideas and solutions [22-31]. In literature, very few significant theoretical studies, research findings, recommendations for the design of VLS and processing of information results in such systems are highlighted. Appeared a need to analyze, to generalize and to justify existing approaches to implementation of e-commerce and building of VLS. The actual problem of the creation of technological products complex is based on the theoretical study of methods, models and principles of processing information resources in VLS, based on the principle of open systems that allow to manage the process of increase in sales of commercial content. Analysis of the factors enables us to infer the existence of a contradiction between the active development and extension of IT and VLS on the one hand, and the relatively small amount of research on this subject and their locality on the other. This contradiction raises the problem of containment of innovation development in the segment of electronic content commerce through creation and introduction of appropriate new advanced IT that affects negatively the growth of this market [32-45]. Within this problem there is an urgent task of developing scientifically based methods of processing information resources of electronic content commerce, and building process on the basis of software for the creation, dissemination and sustainability of VLS. In this paper a study to identify patterns, characteristics and dependencies in information resources processing in VLS was carried out.

3 The Main Content of Work

The basic terms and concepts had been defined and concretized. The following of them had been used in the work. The *content* is the totality of all data (commercial, service, extra, etc.) that implement a certain set of meta-models (a model that describes the structure and principles of a particular model) and the models of copies concentrated among information system. The *commercial content* is a part of the general content, which is the subject of the purchase, the user's use and owner's profit; textual, visual or audio content as part of the user's experience according to the information resources (text, images, audio, video and software). The content control is control functions for receiving, analyzing, saving, searching and spreading of the content. The information resource is an object of the means' action and information technology; set of documents in the information systems (libraries, archives, data banks, etc.).

The information product is documented information prepared and designed to meet the needs of users.

The e-commerce is a field of digital economy and of e-business, including all financial and commercial transactions over computer networks and business processes associated with conducting these transactions. E-content commerce is a field of e-commerce, where the commercial content is an object of financial and commercial

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transactions and business processes. The system of e-content commerce is a system of processing of commercial content and related information, human, technical, organizational and financial resources, to support and distribute commercial content. The content lifecycle is a multi-complex process that takes place in the content control via the various stages / phases of the publication with a set of properties such as collaboration, records' control, digital asset and versions that are supported by various technologies. Large torrents and volumes of different content are in VLS. Most of these content's torrents are made up of easily formalized and automated procedures and commercial content. But there is no general approach to the process of modeling, design, development and implementation of VLS. The formal description of the VLS is presented as

$$Y = \langle X, Q, C, V, H, Z, T, \delta \rangle, \quad (1)$$

where $X = \{x_1, x_2 \ldots, x_{n_X}\}$ is a set of content from various sources (information re-resources, authors, moderators, editors, visitors, journalists, users, administrators, analysts), $Q = \{q_1, q_2 \ldots, q_{n_Q}\}$ is set of users' information requests, $C = \{c_1, c_2 \ldots, c_{n_C}\}$ is a content set, $V = \{v_1, v_2 \ldots, v_{n_V}\}$ is a set of conditions content maintenance and external influences on the system environment, $H = \{h_1, h_2 \ldots, h_{n_H}\}$ is a set of processing content's conditions, $Z = \{z_1, z_2 \ldots, z_{n_Z}\}$ is set of information resource's components, $T = \{t_1, t_2 \ldots, t_{n_T}\}$ is time of transaction processing content, $Y = \{y_1, y_2 \ldots y_{n_Y}\}$ is an outgoing characteristics' totality of the system, δ is an operator which form the statistics' analysis of VLS's functioning. The process which works up information resources (1) is described by the operator $y_j(t_{p+1}) = \delta(x_i, q_d, c_r, v_l, h_k, t_p, z_w)$.

The value $y_j = \{y_{1j}, y_{2j}, \ldots, y_{gj}\}$ is a totality of data over a specified period of time, where y_1 is number of visits, y_2 is average time of information resource's attendance (min: c), y_3 is a rate of refusals (%), y_4 is an achieved goal of a search, y_5 is content's dynamic (%), y_6 is the total number of viewed pages, y_7 is number of viewed pages per visit, y_8 are new visits, y_9 are absolute unique visitors, y_{10} is a traffic's source in % and so on. The impact of the values x_i, q_d, c_r, v_l, h_k on the values z_w and y_j as a result of the e-commerce's content are unknown and unexplored. Connections between the input data, content, input data and the processing of information resources in the system are undisclosed. This justifies a goal, an actuality, an expediency and a research's areas.

4 Information Resources Processing

The main stages of the process of information resources' elaboration in VLS are

formation, control and maintenance of commercial content, with the following links: *content* $\rightarrow$ *content's formation* $\rightarrow$ *database* $\rightarrow$ *content's control* $\rightarrow$ *informational resource or user's request* $\rightarrow$ *content's control* $\rightarrow$ *informational resource* $\rightarrow$ *content's maintenance* $\rightarrow$ *database*. Then from (1) $\delta : X \rightarrow Y$ conveyed functions' superposition $\delta = \gamma \circ \beta \circ \alpha$, where α is an operator of commercial content's formation, β is an operator of commercial content's control, γ is an operator of commercial content's maintenance. The VLS is presented as

$$Y = \langle X, Q, H, C, V, Z, T, \alpha, \beta, \gamma \rangle . \tag{2}$$

The operator of commercial content's formation α is a commercial content's reflection c_r into new state c_{r+1}, that differs from the previous due to emergence of a new piece of content Δc which complements the previous state $c_{r+1} = c_r + \Delta c$, then $\alpha : (c_r, t_p, X, u_f) \rightarrow (c_{r+1}, t_{p+1})$, where $u_f = \{u_{1f}, u_{2f}, \ldots, u_{n_{Uf}}\}$ is set of formation of commercial content's conditions c_r as

$$c_r = \left\{ \bigcup_i^{n_X} x_i \middle| \begin{array}{l} \forall x_i \in X_{u_f}, x_i \notin X_{\overline{u_f}}, \exists u_f \in U_{x_i}, u_f \notin U_{\overline{x_i}}, \\ X = X_{u_f} \cup X_{\overline{u_f}}, U = U_{x_i} \cup U_{\overline{x_i}}, f = \overline{1, n_U} \end{array} \right\}, \tag{3}$$

where the set of conditions u_f commercial content's formation c_r is defined as

$$u_f = \left\{ \bigcup_j^{k} u_{jf} \middle| \begin{array}{l} \forall u_{jf} \in U_{x_i}, \exists x_i \in X_{u_f}, u_{jf} \notin U_{\overline{x_i}}, \\ U = U_{x_i} \cup U_{\overline{x_i}}, X_{u_f} \subseteq X, f = \overline{1, n_U}, i = \overline{1, m} \end{array} \right\}. \tag{4}$$

The operator of commercial content's control β is a reflection of commercial content c_r into new state c_r', which is different from the previous state due to values of the defining parameters $h_k \rightarrow h_k'$ (actuality, completeness, relevance, authenticity, trustworthiness) that satisfy predefined requirements

$$\beta : (q_d, z_w, c_r, h_k, u_M, t_p) \rightarrow (c_r', h_k', z_{w+1}, t_{p+1}), \tag{5}$$

where $q_d \in Q$, $h_k \in H$, $h_k = \{h_{1k}(c_r, q_d), \ldots, h_{n_H k}(c_r, q_d)\}$ is set of conditions of commercial content's control as

$$z_w = \left\{ \bigcup_{r=1}^{n_C} c_r \middle| \begin{array}{l} \forall c_r \in C_{q_d}, \exists q_d \in Q, \exists h_k \in H_{c_r}, c_r \notin C_{\overline{q_d}}, \\ h_k \notin H_{\overline{c_r}}, C = C_{q_d} \cup C_{\overline{q_d}}, H = H_{c_r} \cup H_{\overline{c_r}}, \\ d = \overline{1, n_Q}, k = \overline{1, n_H} \end{array} \right\}, \tag{6}$$

where the set of defining parameters' values form as $h'_k = h_k + \Delta h$. The operator of commercial content's maintenance γ is a commercial content reflection c_r in the collection of values y_i, which is formed as result of the analysis, monitoring, evaluation of user's interaction, searching engines and other information resources that are the basis for making decisions about development and commercial content's control

$$\gamma : (c_r, q_d, v_l, h_k, z_w, u_S, t_p) \to y_i, \tag{7}$$

where $v_l = \{v_{1l}(q_i, h_k, c_r, z_w, t_p), \ldots, v_{n_V l}(q_i, h_k, c_r, z_w, t_p)\}$ is set of conditions of content's maintenance and impact of the environment on the system. Outgoing data is implemented in

$$y_j = \left\{ \bigcup_{l}^{n_V} v_l \middle| \begin{array}{l} \forall v_l \in V_{q_d} \cup V_{z_w}, \exists q_d \in Q, \exists z_w \in Z, \exists h_k \in H_{c_r}, \\ v_l \notin V_{\overline{q_d}}, v_l \notin V_{\overline{z_w}}, V_{q_d} \subset V, V_{z_w} \subset V, d = \overline{1, n_Q}, \\ w = \overline{1, n_Z}, r = \overline{1, n_C}, k = \overline{1, n_H} \end{array} \right\}. \tag{8}$$

The process of commercial content's formation for an information resource provides a mapping of the input data from different sources to the set of formed commercial content and saved in an appropriate database in the VLS as $S(x_i) \to x_i \to X \to \alpha(u_f, x_i, t_p) \to c_r \to C \to D(C)$, where $S(x_i)$ is a data source, $D(C)$ is database of commercial content. The commercial content's formation $\alpha : X \to C$ is presented by superposition of functions

$$\alpha = \alpha_7 \circ \alpha_6 \circ \alpha_5 \circ \alpha_4 \circ \alpha_3 \circ \alpha_2 \circ \alpha_0, \tag{9}$$

$$\alpha = \alpha_7 \circ \alpha_6 \circ \alpha_5 \circ \alpha_4 \circ \alpha_3 \circ \alpha_2 \circ \alpha_1, \tag{10}$$

where α_0 is an operator of commercial content's creating; α_1 is an operator collecting content from multiple sources; α_2 is an operator which identifies duplication of commercial content; α_3 is an operator commercial content's formation; α_4 is an operator which identifies key words and commercial content's concepts; α_5 is an operator of commercial content's automatic categorization; α_6 is an operator which forms commercial content's digests; α_7 is operator of commercial content's selective distribution. The process of commercial content's formation is presented as

$$\alpha = \langle X, T, U, C, \alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7 \rangle. \tag{11}$$

1. The operator of the commercial content's establishment is mapping of input data from various sources of information into commercial content that is different

from the previous state of the commercial content due to its actuality as $\alpha_0 : (X, U_C, T) \to C_0$.

2. The operator of the commercial content's collecting is reflection of input data from the authors or systems' moderators in commercial content that is different from the previous state of the commercial content due to its trustworthiness and actuality as $\alpha_1 : (X, U_G, T) \to C_0$.

3. The operator which identifies commercial content's duplication is a reflection of a commercial content into a new state that is different from the previous state according to its uniqueness as $\alpha_2 : (C_0, T, U_B) \to C_1$.

4. The operator of commercial content's formatting is display content in a new state that is different from the previous state according to its format of presentation as $\alpha_3 : (C_1, U_{FR}, T) \to C_2$.

5. The operator which identifies commercial content's keywords is a commercial content's reflection into a new state that is different from the previous state due to the presence of the set of keywords that describe the general content as $\alpha_4 : (C_2, U_K, T) \to C_3$.

6. The operator which categorizes content is a content's reflection into a new state due to it's validation, which is different from previous state due to it's belonging to the set of thematic content as $\alpha_5 : (C_3, U_{CT}, T) \to C_4$.

7. The operator which forms commercial content's digests is a commercial content's reflection into a new state that is different from the previous state due to the emergence of a new piece of content as a summary of its complement previous state as $\alpha_6 : (C_4, U_D, T) \to C_5$.

8. The operator of commercial content's selective distribution is a commercial content's reflection into a new state that is different from the previous state due to its purpose and spread among the target audience as $\alpha_7 : (C_5, U_{Ds}, T) \to C_6$.

The set of operators $\{\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7\}$ is adequate in the process of commercial content. The process of commercial content is presented by the following scheme of links: $User(q_d) \to q_d \to Q \to H(c_r, q_d) \to \beta(q_d, c_r, h_k, t_p) \to z_w \to User(z_w)$, where $User(q_d)$ is a formation of user's request; $User(z_w)$ is browsing by user's answers to a request q_d. The operator of commercial content's control $\beta : C \to Z$ is presented as superposition of functions $\beta = \beta_4 \circ \beta_3 \circ \beta_2 \circ \beta_1$, where β_1 is an operator of editing and modification of commercial content; β_2 is an operator which determines the weight of the block of commercial content; β_3 is an operator which form values of defining parameters of commercial content's control; β_4 is an operator which form and present information resource pages. The commercial content management is presented as

$$\beta = \langle C, Q, H, U, T, Z, \beta_1, \beta_2, \beta_3, \beta_4 \rangle . \quad (12)$$

1. The operator of the editing and modification of commercial content is

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presented as $\beta_1 : (c_r, h_k, u_l, t_p) \to c'_r$.

2. The determination operator of the block weight and formation the base search images of commercial content is presented as $\beta_2\ (c'_r, y_j, u_l, t_p) \to c''_r$.

3. The formation operator of the determinant meanings parameters of control is presented as $\beta_3 : (c''_r, h_k, u_l, t_p) \to h'_k$.

4. The formation and presentation operator of information resource page is presented as $\beta_4\ (c''_r, h'_k, z_w, q_d, t_p) \to z_{w+1}$, where $h_k \in H$, $h_k, = \{h_{1k}, h_{2k}, ..., h_{mk}\}$ is the set of process parameters that control commercial traditional content (h_{1k} is actuality, h_{2k} is relevance, h_{3k} is completeness, h_{4k} is authenticity, h_{5k} is authenticity of commercial content); $u_l \in U$, $u_l = \{u_{1l}, u_{2l}, ..., u_{nl}\}$ is multiple criteria process to control commercial content (u_{1l} is the coefficient of the block location in the commercial content, u_{2l} is the coefficient of keywords in the block , u_{3l} is coefficient of the key words statistical importance, u_{4l} is the coefficient of keywords from the user request, the coefficient of the keywords volume from the request). The process of commercial content maintenance is presented as scheme of links: $User(q_d, z_w) \to q_d \to z_w \to V(q_d, z_w, t_p) \to \gamma(v_l, h_{k,} c_r, z_w, t_p) \to y_j \to Moderator(y_j)$.

Support of commercial content $\gamma : Z \to Y$ is represented by a superposition of functions $\gamma = \gamma_8 \circ \gamma_6 \circ \gamma_5 \circ \gamma_3 \circ \gamma_1$, or $\gamma = \gamma_8 \circ \gamma_7 \circ \gamma_5 \circ \gamma_4 \circ \gamma_2$, where γ_1 is the operator of formation digital flows portraits of commercial content , γ_2 is the operator of formation digital portraits of regular users, γ_3 is the operator of identification of thematic subjects in the plural of new commercial content, γ_4 is the operator of identification of commercial content thematic subjects with a set of user requests, γ_5 is the operator of tabulation of the commercial content relations, γ_6 is the operator of calculating the ratings of commercial content, γ_7 is the operator of calculating the ratings of regular users, γ_8 is operator of the statistical analysis system functioning.

The process of commercial content support is presented as

$$\gamma = \langle Q, C, H, V, T, Z, Y, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6, \gamma_7, \gamma_8 \rangle, \quad (13)$$

1. The operator of formation digital flows portraits of content. It is a mapping of the set of relevant commercial content in a variety of settings, which describe the thematic needs of the target audience according to certain criteria that is defined by the moderators as $\gamma_1 : (V_{Pc}, C, H, Q, T) \to Y_{Pc}$.

2. The operator of formation portraits of regular users is the mapping of the relevant commercial content set in a variety of settings which describe the thematic needs of the target audience according to certain criteria that is defined by moderators as $\gamma_2 : (V_{Pq}, Q, H, Z, T) \to Y_{Pq}$.

3. The operator of identification of thematic subjects in the plural of new

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commercial content which is mapping of new commercial content set from a variety of sources of information in the set of keywords for new rubric of commercial content which describe a topic sentence of these reliable sources according to certain criteria that is defined by the moderators as $\gamma_3 : (C, H, X, V_T, T) \to Y_T$.

4. The operator of identification of content thematic subjects with a set of user requests is the mapping of multiple user requests to the set of keywords for the new rubric of content which describe the thematic needs of registered users according to certain criteria that is defined by the moderators as $\gamma_4 : (C, H, Q, V_T, T) \to Y_T$.

5. The operator of tabulation of the commercial content relations by keywords and frequency of visits is the mapping of commercial content in a new state, which is different from the previous large number of links content based on criteria such as thematic, the relevance factor rating, sequence and frequency of viewing, popularity, actuality, authorship as $\gamma_5 : (C, V_c, T) \to Y_C$.

6. The operator of calculating the ratings of content is the mapping of commercial content to a new state which is different from the previous state of commercial content by the emergence of new content in the form of ratings on certain criteria, that complements the previous state as $\gamma_6 : (C, Q, H, Y_C, V_{Rc}, T, \theta, \vartheta) \to Y_{Rc}$.

7. The operator of calculating the ratings of regular users – the mapping of the set permanent portraits of classified users in a new state , which is different from the previous condition of commercial content by the emergence of a new part of the characteristics of these users in the form of ratings on certain criteria, that complements the previous state as $\gamma_7 : (C, Q, H, Y_C, V_{Rm}, T) \to Y_{Rm}$.

8. The operator of the statistical analysis of system functioning is the mapping of statistic system functioning in a collection of values, which create as result of analysis, monitoring, evaluation of user interaction, search engines and other information resources, which is the basis of making decisions regarding to the content creation and management as $\gamma_8 : (Y_P, Y_T, Y_C, Y_R, Z, H, V, T) \to Y$.

The subsystem of content formation is implemented as a content-monitoring complex for content gathering from different sources of data which provides a content database creation according to the information needs of users. As a gathering and primary processing result of content is reduced to a single format, classified according to the specified categories. And he is credited descriptors with keywords. This facilitates the process implementation of content management. Tasks of Web content management subsystem are: database formation, rotation and providing access to it; the operational and retrospective databases formation; the user experience personalization; personal user queries and sources storing; operation statistics analysis; search providing in database; initial forms generation on information resources; information interaction with other databases; the an information resource formation. Content management subsystem is implemented through caching (representation module generates a page once; then it is several times faster loaded from the cache, which is updated automatically after a certain period of time or when making changes to specific sections of an information resource, or manually by administrator command) or information blocks formation (blocks conservation in the information resources editing stage and page collection from these blocks at the user

request of the relevant page). Content support subsystem provides information portraits formation, thematic storyline identification in content flows, the content relationship tables building, content rankings calculation, new events identification in their content flows, their tracking and clustering. Analysis of commercial support content helps identify causes of the formation of the target audience for a set of characteristics of functioning of VLS. By adjusting the a set of thematic commercial content, its uniqueness, efficiency of its formation and adequate management according the individual needs of the regular user, you can to model the verge of the target social audience and the number of unique visitors from search systems.

5 Conclusion

The paper is solved the actual scientific problem of methods and means research and development for commercial Web content processing in e-business systems by using the developed mathematical software for the appropriate systems creation, which made it possible maintain the life cycle of commercial content on the level of developer (the time and costs reducing for development, quality improvement through the use of proven solutions).

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