The Algorithm of Electronic Multilingual Terminological Dictionary Compilation

Tetiana A. Vakaliuk[1,2,3][a], Oksana A. Chernysh[1][b] and Vitalina O. Babenko[4][c]

[1]*Zhytomyr Polytechnic State University, 103 Chudnivsyka Str., Zhytomyr, 10005, Ukraine*

[2]*Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine*

[3]*Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine*

[4]*V. N. Karazin Kharkiv National University, 4 Svobody Sq., Kharkiv, 61022, Ukraine*

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Abstract: The aim of the present scientific research is to provide a thorough analysis of the algorithm of electronic multilingual terminological dictionary compilation. Electronic multilingual terminological dictionary is viewed as a dynamic electronic lexicographic edition that provides translation, explanatory, encyclopedic parametres of terminological units and is open to current trends in its fields of knowledge representation. Electronic multilingual terminological dictionary covers five knowledge areas, namely Information Technologies, Linguistics, Accounting and Taxation, Engineering, and Economics. It provides English, French, German, Polish and Russian equivalents with encyclopedic reference in all target languages. Moreover, it is absolutely adapted to constant updating, extension and integration with other systems needed. Such dictionary creation presupposes determination of its volume and structure, lexical units' selection and their frequency feedback, and proper arrangement of translation equivalents. Therefore, the algorithm of electronic multilingual terminological dictionary compilation includes seven stages that are dedicated to register creation and arrangement, information system creation and trial, as well as dictionary set-up. All stages are interconnected and interrelated. Accordingly, meticulous stages completion significantly contributes to quality electronic multilingual terminological dictionary compilation.

1 INTRODUCTION

Dictionaries have already become an all-important issue in our modern world. Due to constant technological and scientific progress their importance is inevitable. Dictionaries are universal tools to foster cross-cultural professional communication thus contributing to society advancement. They significantly contribute to thorough objective description of scientific and technical processes. Dictionaries facilitate the users' understanding of lexical units meaning. Therefore, lexicographers are constantly trying to enhance dictionary quality to absolutely satisfy the target users' needs thus making dictionaries a sufficient source of information.

In the digital era, the computer technologies introduce new interactive ways to overcome time and distance (Toman and Michalik, 2013; Kazhan et al., 2020). Computerization of dictionary compilation makes the search for specific information much easier and more productive. It greatly reduces the timeframes and provides more opportunities to acquire sufficient knowledge on a certain lexical item. Moreover, electronic dictionaries are known for their thesaurus, encyclopedia, learning programs available, data transpost possibilities and other added features. They are user friendly and provide all the necessary information assisting in both private and professional communication. Therefore, electronic dictionaries have already become beneficial for creating a bond among different cultures which is of a great advantage for business communication and scientific advancement.

Furthermore, electronic dictionaries are valued for

[a] https://orcid.org/0000-0001-6825-4697
[b] https://orcid.org/0000-0002-2010-200X
[c] https://orcid.org/0000-0002-4816-4579

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their translation capability and viewed as the main tool of scientific text translation (Tarasenko et al., 2021). They save a lot of time, as the translation of terminological units is done within seconds. Electronic dictionary is mobile and can be easily applied wherever and whenever it is needed. Therefore the development of methods, techniques and algorithms of dictionaries compilation is of primary importance.

1.1 Theoretical Background

Research on dictionary peculiarities, its typology, typology of its users, analysis of needs and skills has a long tradition and is presented in (Hartmann, 1983, 1992, 2009; Hausmann, 1976, 1984, 2007; Kosem et al., 2019; Leffa, 1992a,b; Nesi, 1999, 2000, 2013, 2014; Nimb et al., 2020; Pedersen et al., 2009; Müller-Spitzer et al., 2015, 2018) and many others. The term "dictionary" was first coined in Medieval Latin in the 13th century on the basis of Latin derivative 'diction' (word). Dictionary is viewed as a lexicographic edition arranged in some stated order that deals with the individual words of a language and provides their orthography, pronunciation, grammatical characteristics, derivation and history (Stevenson and Waite, 2011). It is a systematically arranged list of socialized linguistic forms derived from the speech-habits of a certain speech community accompanied by the author's remarks on their usage and aimed at the readers' better understanding. Dictionary has various practical purposes. It is a useful reference book, a 'store house' for a language; a detailed guidebook for distinguishing good usages of lexical items from bad usages, a 'court house' for a language (Dash, 2005). It is the source of linguistic and extralinguistic information which is authentic and reliable.

Burada and Sinu (Burada and Sinu, 2009), Kwary (Kwary, 2011), Weschler and Pitts (Weschler and Pitts, 2000), Winkler (Winkler, 2001) have recognized the advantages electronic lexicographic editions. Electronic dictionary (digital dictionary is a generic term for various types of electronic lexicographic editions and is viewed as any reference material presented in electronic form providing information about the lexical units' spelling, meaning, pronunciation and use (Nesi, 2000). Such a dictionary is a computer database of the specifically coded entries to enable quick word search with regard to morphological form and with the possibility of searching word combinations and changing translation direction (Zavarueva, 2020). It is a new structured text including data represented in different media such as audio files, videos, graph-based views etc. that has a definite volume, a clear aim and serves a specific idea. Therefore, an electronic dictionary is networked, linked to a device, and people-oriented.

Several studies suggest electronic dictionaries characteristic features, namely (Zavarueva, 2020; Müller-Spitzer, 2014):

- a peculiar combination of text and hypertext form of lexical material representation;
- verbal as well as non-verbal means of lexical unit description availability;
- sufficient search facilities within dictionary wordlist as well as in various Internet sources.

There have been numerous studies to investigate electronic dictionaries form and function. Thus, all electronic dictionaries are classified according to (Zavarueva, 2020; de Schryver, 2003; Islam and Purkayastha, 2015):

- a dictionary user (a human or a machine);
- languages involved: monolingual, bilingual and multilingual dictionaries;
- form: online (located in the Internet) and electronic (distributed on CD) dictionaries;
- information arrangement: textual and hypertextual (among which one can distinguish between creolized (with extralinguistic elements such as pictures, audio and video) and non-creolized dictionaries);
- operational system and loading mode parameters: dictionaries designed for MS DOS and dictionaries designed for Windows, non-residential (with their own shell program) and residential (called from other applications);
- word list arrangement: frequency-ordered, alphabetically ordered, thesauruses, thematically grouped, concordances, special purpose dictionaries, combined dictionaries etc.;
- information medium and devices: computer (set up on the desktop computers), pocket (recorder in pocket electronic devices), mobile (used in smartphones), stationary (installed on computer hard disc), portable (distributed on CDs), online (available in the Internet) dictionaries;
- language varieties: normative, literary language, regional dialect, social-group dialect dictionaries and others.

Studies of dictionary structure are well documented (Zavarueva, 2020; Atkins and Rundell, 2008; Jackson, 2003). Prior research proves that electronic dictionary has a well-developed architecture that contributes to quick word search. It consists of

macrostructure and microstructure. The macrostructure is viewed as the organization of the lexical entries in the body of a dictionary (Gibbon, 2007) and comes in two types – semasiological and onomasiological. It includes introduction that goes before the body of a dictionary, tables and appendices (supplements) (Čermák, 2010). The microstructure is the organization of lexical information within lexical dictionary entries. It outlines the linguistic unit properties in terms of its content (pragmatics and semantics), structure (syntax and morphology) and rendering (form).

In recent years, research on electronic dictionary compilation has become very popular among linguists (e.g., (Bergenholtz and Bothma, 2011; Rehm et al., 2020; Wright et al., 2013; Wright and Cervetti, 2017)). There exists a considerable body of literature on lexicographical modeling (Kudashev, 2007; Sternyn, 2007), linguistic and machine methods for dictionary compilation (Oettinger et al., 1959), computational approach to lexicography (Atkins and Zampolli, 1994; Čermák and Blatná, 2008), text parsing programs for online dictionaries (Sangeorzan et al., 2008), dictionary writing systems (Rylova, 2010) etc.

Due to constant scientific developments and improvements, significant changes that occur in modern lingual environment are primarily related to terminology. Therefore, terminological units' presentation in electronic dictionaries is in the focus of (Andrianova and Makarova, 2016; Sperberg-McQueen and Burnard, 2004).

The *aim* of our study is to investigate the algorithm of electronic multilingual terminological dictionary (EMTD) compilation. EMTD is viewed as a dynamic electronic dictionary that is open to current trends in its fields of knowledge representation. It is absolutely adapted to constant updating, extension and integration with other systems needed. Moreover, it is rather flexible as for quantitative and qualitative terms. EMTD does not only outline the definition of terms, but also provides English, French, German, Polish and Russian equivalents with encyclopedic reference in the target language. EMTD has a lot of advantages as it aims at providing detailed encyclopedic information which is absolutely necessary for adequate translation. Moreover, it gives illustrative examples that greatly highlight the distinctive features of a terminological unit and shows its usage in different contexts.

2 RESULTS

Electronic dictionary compilation is a meticulous process which takes time and efforts. To compile a quality electronic lexicographic edition all regulations and requirements should be decently followed. In short, the literature pertaining to the peculiarities on dictionary compilation strongly suggests that it is a multifaceted process that includes the following stages (Coward and Grimes, 1995):

- structural, semantic, functional and socio-cultural understanding of language(s);
- structuring and ordering entry information;
- compiling the lexical database;
- checking and refining lexical database information;
- manipulating the data for analytic or other purposes;
- output which presupposes deciding on the format and making the necessary adjustments;
- printing (for printed dictionaries);
- marketing and distribution.

The analysis of existing approaches to electronic dictionaries compilation has driven the further development of the algorithm of EMTD compilation (figure 1).

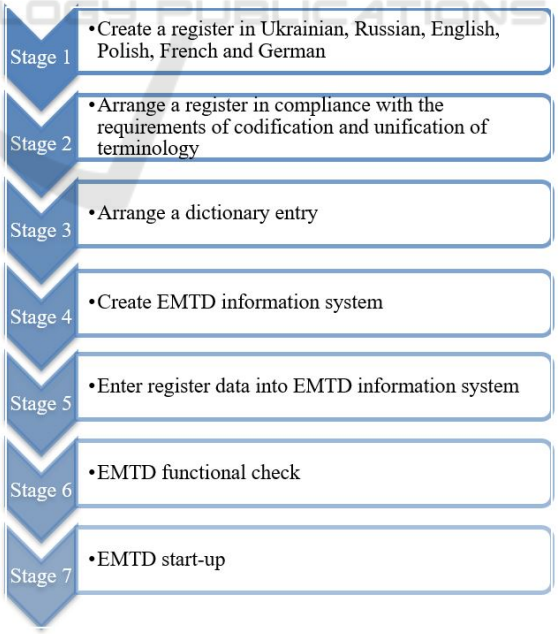

Figure 1: The algorithm of electronic multilingual terminological dictionary compilation.

EMTD compilation undergoes several stages aimed at improving its quality and satisfying the dictionary users' needs. It starts with the creation of the register in the target languages – Ukrainian, Russian, Polish, French and German. As soon as the register is ready, it is sufficiently checked and arranged according to the requirements of terminology codification and unification. The next step is dedicated to EMTD entry structure that presupposes thorough macro and microstructure arrangement. Then EMTD information system is created and register data is entered. After that EMTD should undergo a thorough functional check. Last but not least is EMTD start-up.

Moreover, EMTD creation presupposes comparative and contrastive studies that are based on general principles of terminology analysis. The following principles include comparability, consistency, and sequence of linguistic data analysis (Sternyn, 2007). Comparative analysis is conducted at the level of subsystems, fields and groups, whereas contrastive analysis is done at the level of a definite terminological unit from one language to its possible equivalence in the languages given.

For the current research, it is sufficient to point out the peculiarities of the stages mentioned above.

2.1 Creating a Register

As it has been previously reported, the basis of any dictionary lies in its register. Each word of the register has its own EMTD entry with peculiar structure. A terminological unit is the main structural component of the entry that highlights its grammatical parameters, phonetic and morphological peculiarities as well as synonymic variants if any (Vakaliuk and Chernysh, 2020).

It should be noted that for terminological units' selection we use only authentic texts that meet the following requirements:

- authentic language (written in the author's mother tongue);
- sufficient academic degree of the author (Doctor of Philosophy (PhD), Associate Professor, Professor);
- issue date (less than 10 years).

To create the register the main academic principle of terminological units' selection should be implied. The principle presupposes conducting linguistic and statistical analysis of lexical units from selected sources. The analysis starts with ranking of the terminological units to the frequency of their usage. If a term is widely used the compilers include it in the register.

Each EMTD section is dedicated to a certain area of knowledge and consists of 300 entries. Therefore, a careful and thorough terminological units' minimum selection is a significant prerequisite for efficient EMTD. A well-organized and sufficiently selected register is necessary for the expression of an idea or concept. Therefore, decent register creation greatly depends on mutual efforts and effective cooperation of linguists and specialists in the corresponding subject areas.

2.2 Arranging a Register

Arranging the register special features of terminological units should be considered. Therefore, contrastive and systemic analysis should be implied. Contrastive description of the lexical units' meanings from various semantic categories and different languages has a paramount value. It helps to avoid unwanted terminological confusion and significantly contributes to the users' better understanding of a certain phenomenon. Systemic analysis is done both at the level of comparable subsystems and parallel pairs of terms. It aims at coordination and harmonization of terminological units. Peculiar attention is given to avoid terminological confusion as presence of several terminological units' translations and lack of their thorough distinguishing features as well as erroneous translation equivalents lead to distortion of a term and cause misunderstanding. Thus, terminological system modeling requires the use of comparable logical-conceptual schemes.

2.3 Arranging the Dictionary Entry

Recent theoretical developments have revealed that EMTD compilation should be done in accordance with the following requirements (Verbinenko, 1):

- thorough and sufficient vocabulary coverage of the subject areas;
- availability of the necessary information about the terminological units;
- avoidance of redundant information that increases the dictionary volume, prevents easy word search and consequently causes misunderstanding;
- unification of the dictionary structure and apparatus of links to facilitate the users' search;
- coherence between the dictionary structural components.

Therefore, EMTD entry is of primary importance as it is one of the main EMTD structural components. EMTD entries are viewed as sets of information about

terminological units and classified into thematic areas: Information Technologies; Linguistics; Engineering; Accounting and Taxation; and Economics. EMTD entry arrangement should significantly contribute to thorough systematization of terminological unit knowledge on all levels – phonetic, morphological and semantic, therefore it comprises the following parts:

- definition which is one of the most significant constituents of a EMTD entry that provides explanation of terminological units meaning. It serves to resolve the communicative EMTD users needs of decoding and encoding (Atkins and Rundell, 2008). Definition should include only relevant information to meet the expectations of the target users and comply with the general principles (Landau, 2001). It should avoid circularity therefore contributing to better understanding of a terminological unit meaning. Moreover, it should define every word used in a definition not to prevent the user from full understanding. Definition should explain but not just talk about the word and its usage, thus being enough informative
- pronunciation contributes to the correct way of uttering terminological units;
- grammatical information indicates a part of speech, differentiates between transitive and intransitive verbs, countable and uncountable nouns etc.;
- labels are viewed as orientation marks of the region, field or any other specifications according to which the use of a terminological unit can be limited. Labels fall into three types: status, regional and subject. Among them register, style, time and attitude may be as well distinguished (Atkins and Rundell, 2008);
- semantic relations particularly refer to synonyms, antonyms, collocations, cases of hyponymy or hypernymy (de Sousa, 2009).
- phraseology includes phrasal verbs, idioms and collocations which are usually stated at the end of the entry. It may be marked with signs referring to limitations in a word use and followed by relevant examples;
- etymology highlights the origin of a word and its development during the time. It significantly contributes to better understanding of the current meaning and thus enhances the general knowledge of it;
- providing examples is a negotiable issue and depends on the users' expectations. Although, examples should be natural and typical, thus present a term in the most frequent contexts, syntactic patterns, collocations and multiword expressions keeping the balance between too much context and too little (Atkins and Rundell, 2008). Moreover, examples should be informative implying only relevant information not dispersing the users' attention. Last but not least refers to intelligibility which is gained by avoiding sophisticated lexis and structures wherever possible (Atkins and Rundell, 2008).

Most early studies as well as current work focus on the importance of a thorough terminological unit definition. Undoubtedly, a good definition facilitates EMTD users' understanding and greatly contributes to their professional competence development. Accordingly, it should have the following features (Devel and Kovalchuk, 2016):

- have no logical contradictions. The definition should be transparent in meaning. It should not imply difficult terms for rendering the notion;
- be clear and precise;
- have positive predicate;
- be neither overdefined nor underdefined;
- be defined in the simplest possible language.

Furthermore, to meet EMTD users' requirements the compilers make the lexicon easily searchable considering the following features (Burke, 1998):

- headword lookup should be in accordance with printed dictionaries primary macrostructure thus enabling EMTD users to access EMTD entries by simply searching for headwords matching a string they type in;
- part-of-speech indices that help EMTD users to search for entries of a certain subcategory of a part of speech;
- etymology or morphological composition indices;
- register indices that imply reference to literary, slang, professionalisms and other words;
- semantic field indices to provide EMTD users with a hyperlink to a list of all other terms belonging to a particular area of knowledge;
- phonological content of headwords to contribute to EMTD users' correct pronunciation.

EMTD should become a sufficient tool in helping EMTD users to enhance understanding in their readings. Hence, EMTD offers the opportunity of quick six-language A/Z search that makes the search process rather user-friendly and less time-consuming.

2.4 Creating EMTD Information System

Creating EMTD information system requires much time and consideration. The primary concern goes to laying out the database and data flow to the sort of terminological units' visual presentation on the page. Undoubtedly, the era of designing electronic dictionaries in the same way as paper dictionaries has already gone (Heid et al., 2012). Therefore, EMTD should be architected in order to satisfy its users' needs. Every EMTD feature has to be thoroughly planned to make the users' benefit from the dictionary layout.

EMTD has minimal constraints on adding new features or implying more languages. It has two-level expandability, namely: depth (new terminological items may be added to each language); width (new languages may be added). Consequently, EMTD could be further developed and enriched which is significantly important due to constant scientific and technological progress. Thus, we have no technical obstacles to further develop the project on EMTD compilation.

Moreover, EMTD enables smooth data manipulation. It is hosted on university servers that make all the documentation, codebase and language database securely backed up. Furthermore, to satisfy EMTD users' needs, three device types are proposed: computers, tablets and mobile phones. Therefore, the compilers have to ensure optimal accessibility of data on display to EMTD users. Accordingly, responsive design-driven methodology to scale EMTD design down to resolution of 480x960 pixels retaining all the features of the page is implied.

2.5 Entering Register Data Into EMTD Information System

As soon as EMTD information system is created and the register is done in compliance with the requirements of terminology codification and unification, entering register data stage begins. The following stage is rather time-consuming and requires significant efforts. Nonetheless, thorough and meticulous approach used significantly facilitates the process.

2.6 EMTD Functional Feedback

EMTD quality greatly depends on active implementation of EMTD users' needs. Therefore, to corroborate the necessary data several research instruments are used. Open-ended questionnaires, focus group interviews, and email responses are rather helpful in getting EMTD users feedback. A sound idea lies in an urgency to obtain the feedback from the target users while dictionary compilation is still in progress (de Schryver, 2003). Thus, the dictionary-making process is strictly guided in order to satisfy all target users' needs.

What is more, EMTD evaluation is carried out by linguists and specialists in the corresponding areas of knowledge. The specialists take into consideration its suitability and applicability to the curriculum as well as test its features, for instance:

- accuracy;
- multi aspect educational value;
- up-to-date educational standards;
- sufficient language wording;
- complete data;
- ability to encourage and motivate the users' interest;
- ability to improve the users' professional skills.

The following features guarantee the quality of EMTD and its applicability in the educational process. Moreover, EMTD is tested for its reliability, interactivity, controllability, menu, search and control methods, appropriate font, consistent screen layout, technical errors etc.

2.7 EMTD Start-up

Right after EMTD information system is checked, it is given wide public access. It is worth noting that EMTD start-up is not the final stage. This stage presupposes numerous testing of EMTD functions, which is of paramount importance for further EMTD improvement and, accordingly, support.

3 CONCLUSIONS

Constant scientific and technological progress greatly necessitates lexicographical modeling of electronic multilingual terminological dictionaries that hold a central place in the wide range of terminographic editions. EMTD is viewed as a special electronic lexicographic edition that is characterized by translation, explanatory, encyclopedic parameters. It is divided into 5 thematic areas, namely Information Technologies, Linguistics, Accounting and Taxation, Engineering, and Economics. It presents information about terminological units on all levels – phonetic, morphological and semantic. EMTD is valued for quick six-language A/Z search that makes it rather user-friendly. From the research that has been carried out,

it is possible to conclude that the process of EMTD compilation undergoes 7 stages including register creation and arrangement as well as EMTD information system creation and functional check. Following the requirements of EMTD compilation algorithm contributes to a quality electronic dictionary creation. Future investigations are necessary to validate the kinds of conclusions that can be drawn from this research. In addition, investigating EMTD model might prove important.

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