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FRAME MODELLING OF THE ENGINEERING TERMINOLOGY SYSTEM (BASED ON LANGUAGES OF VARIOUS STRUCTURES)

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ABSTRACT: The study aims to unify the terminological elements of the sublanguage of electrical engineering by applying frame analysis on the examples of German, French, Kazakh and Russian. The study examines the process of emergence and consolidation of terminological phrases in the compared languages by applying frame analysis based on the sublanguage of electrical engineering. The analysis revealed that the frame models were structured using a core with frames and subframes and a periphery with slots and sub-slots. When comparing the number of elements of frame models, the study concluded that the number of frames and subframes in the languages under consideration was the same, while at the conceptual levels of slots and sub-slots, the indicators differed. This work can be used for further study of frame semantics, cognitive and frame modelling in national languages, and comparative linguistic research based on the analysis of the terminographic field of electrical engineering.

KEYWORDS: Slots, conceptual levels, periphery, quantitative indicators, field of knowledge.

MODELADO DE ESTRUCTURAS DEL SISTEMA TERMINOLÓGICO DE INGENIERÍA (BASADO EN LENGUAJES DE DIVERSAS ESTRUCTURAS)

RESUMEN: El estudio tiene como objetivo unificar los elementos terminológicos del sublenguaje de la ingeniería eléctrica mediante la aplicación del análisis de marcos en los ejemplos de alemán, francés, kazajo y ruso. El estudio examina el proceso de surgimiento y consolidación de frases terminológicas en los idiomas comparados mediante la aplicación del análisis de marcos basado en el sublenguaje de la ingeniería eléctrica. El análisis reveló que los modelos de marcos se estructuraron utilizando un núcleo con marcos y submarcos y una periferia con ranuras y subranuras. Al comparar el número de elementos de los modelos de marcos, el estudio concluyó que el número de marcos y submarcos en los idiomas en consideración era el mismo, mientras que a niveles conceptuales de ranuras y subranuras, los indicadores diferían. Este trabajo puede utilizarse para un mayor estudio de la semántica de marcos, el modelado cognitivo y de marcos en los idiomas nacionales, y la investigación lingüística comparativa basada en el análisis del campo terminográfico de la ingeniería eléctrica.

PALABRAS CLAVE: Ranuras, niveles conceptuales, periferia, indicadores cuantitativos, campo de conocimiento.

MODÉLISATION DES STRUCTURES DU SYSTÈME TERMINOLOGIQUE DE L'INGÉNIERIE (BASÉE SUR DES LANGAGES DE DIFFÉRENTES STRUCTURES)

RÉSUMÉ : L'étude vise à unifier les éléments terminologiques du sous-langage de l'ingénierie électrique en appliquant l'analyse des cadres à des exemples en allemand, français, kazakh et russe. L'étude examine le processus d'émergence et de consolidation des expressions terminologiques dans les langues comparées en appliquant l'analyse des cadres basée sur le sous-langage de l'ingénierie électrique. L'analyse a révélé que les modèles de cadres étaient structurés à l'aide d'un noyau avec des cadres et des sous-cadres et d'une périphérie avec des emplacements et des sous-emplacements. En comparant le nombre d'éléments des modèles de cadres, l'étude a conclu que le nombre de cadres et de sous-cadres dans les langues considérées était le même, tandis qu'au niveau conceptuel des emplacements et des sous-emplacements, les indicateurs différaient. Ce travail peut être utilisé pour une étude plus approfondie de la sémantique des cadres, de la modélisation cognitive et des cadres dans les langues nationales, ainsi que pour la recherche linguistique comparative basée sur l'analyse du champ terminologique de l'ingénierie électrique.

MOTS CLÉS : Sillons, niveaux conceptuels, périphérie, indicateurs quantitatifs, champ de connaissances.

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1. Introduction

A frame in cognitive linguistics is a structured mental representation of a stereotypical situation. It contains thematically salient variables called slots, which may expand into sub-slots to capture finer distinctions. When such a representation is formalised for a specialised domain, the result is a frame model, a multilayered template that organises expert knowledge together with the lexico-semantic units that express it. Some situations are relatively static, for example the LED arc frame whose core properties rarely change, whereas others are dynamic, such as metal processing by vacuum electrolytic pressure whose parameters vary with each production cycle. Because frame models encode both hierarchy and change, they offer a rigorous way to trace the evolution of technical terminologies over time and across languages.

Electrical engineering provides a particularly instructive testbed (Spaska et al., 2025). Its rapid expansion since the late nineteenth century has generated dense hierarchical terminologies that must be updated continuously, systematised efficiently and exchanged reliably. Recent scholarship confirms the urgency of these tasks. Work on Kazakh lexical-semantic frames (Kassym and Samenova 2023; Baitileuova et al. 2023) and on general principles of terminological systematisation (Zheng 2020; León-Araúz et al. 2020; Hu et al. 2023) shows that robust models are still lacking for many specialised sublanguages. Parallel research on digital corpora (Vezzani and Di Nunzio 2023) and interactive frame annotation tools (Baker and Lorenzi 2020) underlines the need for formal representations that can be fed directly into computational pipelines. Lingua-technical barriers remain, however, because polysemy, opaque translation pairs and uneven borrowing patterns continue to hamper cross-lingual alignment (L'Homme 2021; Liu 2021). Crises such as the Covid-19 pandemic have sharpened these disparities by accelerating the creation and diffusion of new terms (Ma et al. 2021; Al-Khawaldeh et al. 2023).

The present study compares four languages: German, French, Russian and Kazakh, focusing on their electrical engineering frame models. The selection is motivated by three complementary factors. First, the sample maximises typological diversity by pairing two inflectional Indo-European languages with two structurally distinct languages from the Slavic and Turkic branches. Second, German and French were early centres of electrical innovation, Russian served as the lingua franca of engineering across the Soviet bloc, and Kazakh has been rapidly indigenising technical vocabulary since independence, which gives the group historical and technological relevance. Third, contemporary political and economic networks bind these languages through European and Eurasian standards organisations that coordinate grid interoperability, high voltage safety and smart grid roll-outs.

The goal of the study is to demonstrate how frame modelling can reveal convergences and divergences in the structuring of electrical engineering knowledge across differently organised languages. Specifically, the research groups terminological phrases into coherent lexical-semantic sets, constructs comparable frame models for each language, and quantifies the distribution of frames, slots and sub-slots to track areas of terminological density, lexical borrowing and conceptual gaps. By clarifying these patterns, the study offers a replicable method for mapping multilingual terminologies and a practical foundation for developing automated frame-aware terminographic tools.

2. Materials and Methods

For this study, a continuous sample was used from specialised literature, articles in the field, dictionaries, encyclopaedias, and publications in modern electrical engineering periodicals for further frame analysis. The frame models were used to recreate a professional linguistic picture of the world in the field of electrical engineering. The lexical-semantic, conceptual and statistical analyses, as well as the comparative and contrastive methods, were also used to construct frame models of differently structured languages.

The use of frame analysis determined the cognitive mechanisms that trigger the processes of knowledge accumulation and processing. First, the nominal units related to the "Electrical Engineering" frame were grouped. The terms were then classified according to their conceptual affiliation: by subframes (conceptual core), by slots (concepts of the first peripheral level) and by subslots (concepts of the second peripheral level). After that, frame models of German, French, Kazakh and Russian were created and presented in diagrams. Standard frame models of these languages were also developed. Statistical analysis in this study was used to study the quantitative relationship between frames (lexical and semantic groups) represented at all conceptual levels as subframes, slots and subslots. The diagrams with the ratio of frames forming lexical and semantic groups on electrical engineering in each language are shown German, French, Kazakh and Russian. Each category was compared with similar categories in other languages in terms of percentage.

Lexico-semantic analysis in this study was used to identify common and different semantic features in terminological phrases and sort them into lexico-semantic groups represented by frames. Thus, lexical and semantic groups became the basis for the construction of frames, subframes, slots and sub-slots of sublingual electrical engineering. The frame modelling used elements of cognitive analysis, which was used to destructure the explicit cognitive knowledge in the field of electrical engineering based on terminological phrases. Frames, sub-frames included in the core of the concept, slots (concepts of the first peripheral level) and sub-slots (concepts of the second peripheral level) were identified. The comparative and contrastive analysis in this study was used to compare the terminology systems of German, French, Russian and Kazakh based on the frame and lexical-semantic analyses. The comparison of quantitative characteristics was carried out in such frames as “High Voltage Equipment”, “Electrical Machines”, “Apparatus”, “Electric Drive”, “Elements of Air and Cable Lines”, “Physical Phenomena”, and “Measuring Devices”. The data were presented in terms of the number of term combinations and the percentage of different lexical and semantic groups in each language.

The analytical-synthetic method in this study was used to study the theoretical framework related to the construction of frame models, cognitive semantics and the cognitive basis of the frame, decomposition of denotative components in terminological units, consideration of automated data models, statistical and dynamic scenarios in frame modelling. The use of contextual methods to construct frame models, the study of non-equivalent and equivalent vocabulary, the combination of semantic and conceptual information to create frame units, the use of semantic roles and the construction of language models with examples of the introduction of semantic information was also emphasised.

3. Results

A frame is one of the key concepts in cognitive linguistics, representing specially organised holistic fragments of knowledge represented by different linguistic means. The process of understanding consists of the fact that a person retrieves a structure called a frame from memory, which is a data structure containing a description of a stereotypical situation. Thus, the frame structures knowledge about a stereotypical situation, which is a kind of thematic unity. Any frame carries a conventional beginning and includes stable characteristics that allow any member of society to easily recognise this frame. Frame semantics aims to build relationships between linguistic and encyclopedic knowledge, which indicates that it is impossible to understand the semantic meaning of a word without knowledge of the object or phenomenon itself (Zheng et al., 2022). Some situations can be mapped to static scenarios (the “LED arc” frame), while others can be mapped to dynamic scenarios. Thus, the frame is presented as an active structure in which even stable, unchanging features can demonstrate certain dynamics and the elements interact hierarchically with each other. As in any system, in the process of adapting the frame to a particular situation, the top-level elements include stable features, and the bottom-level elements are filled with differentiating features. Frame-semantic theory applies to various discourses that are specific to such subject areas as legal, economic, and medical (Liégeois and Mathysen, 2022).

The creation of frame models based on lexical and semantic analysis is based on the frequency of use of term phrases and keyword matching (Lai et al., 2022). At the same time, the concept of frame proximity allows us to identify lexically triggered frames (Willich, 2022). The frame model of the sphere of electrical engineering sublanguage is a structure of knowledge verbalised by lexical units of the studied terminology system as a multilevel hierarchical structure (Shynkaruk, 2023; Oliveira, 2024). The construction of the frame of the sublanguage of the terminology system of electrical engineering represented the system of scientific knowledge of this field in the mind of a person, in other words, to reflect the cognitive essence of the studied terminology. A frame related to electrical engineering has a certain structure with an internal organisation of its elements and reflects the knowledge about the electrical engineering subject area in the minds of native speakers.

The problem of the relationship between the concepts of “frame” and “concept” can be interpreted as follows: a concept is a generic concept concerning a frame, and a frame is described as a type of complex concept. Frames facilitate human perception of speech information, facilitate the immediate application of the recipient’s knowledge in a new situation, and allow not only to respond adequately to the changing situational context but also to predict future communication behaviour and ways to achieve the planned communication goals (Rozhkov, 2022). Thus, the frame triggers cognitive mechanisms in the memory of each person responsible for storing conventions, conventions, norms, rituals, and human archetypes. A frame is a mental structure of data in a person’s memory that is organised in a certain way (Efremov, 2024b; Shershova and Chaika, 2024). A person perceives this or that language structure as a frame, knowing the semantics of the word, and the sequence of events within a particular situational model. The frame of any terminology system is a kind of hierarchical ladder of subframes that connect this frame with functional relations to the lower frames (Kemiac, 2024; Kulyk, 2023). The frame approach helps to develop cognitive mechanisms and explain the processes associated with the accumulation, processing and transmission of information. The frame structure can be represented by the following components: name and individual units (slots).

The analysis of the features of the electrical engineering terminology system demonstrated several unique properties. Since this study solves the problem of organising term elements by applying frame analysis methods, it is of particular importance that the semantics of the electrical engineering frame cannot be separated from the sum of all knowledge, i.e., from the background culture, habits, social customs of native speakers, etc. The basis of the frame models of the considered terminology systems in differently structured languages is the basic frame of "Electrical Engineering". During the analysis, a basic frame model was compiled that is suitable for all the languages under consideration. Dedicated sub-frames, slots and sub-slots are the basis for diverse terminology systems of the sub-language of electrical engineering.

While compiling the basic frame model, the functional relationships between subframes, slots and sub-slots were identified. Figure 1 shows the basic frame model with sub-frames, slots and sub-slots of the German electrical engineering terminology system.

The developed frame-based model for the French language with subframes, slots and sub-slots is shown in Figure 2.

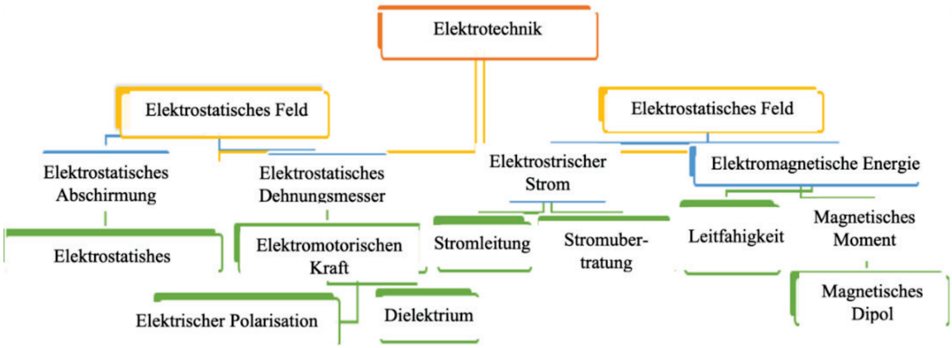

Figure 1. Basic frame model of the electrical engineering terminology system in German.

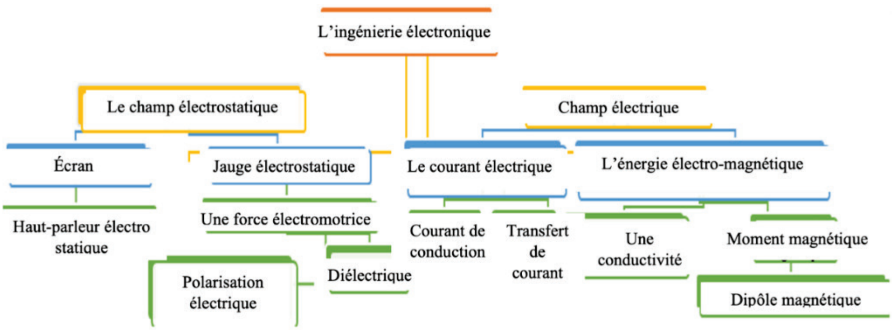

Figure 2. Basic frame model of the electrical engineering terminology system in French.

The frame base model for Russian is shown in Figure 3, and for Kazakh in Figure 4.

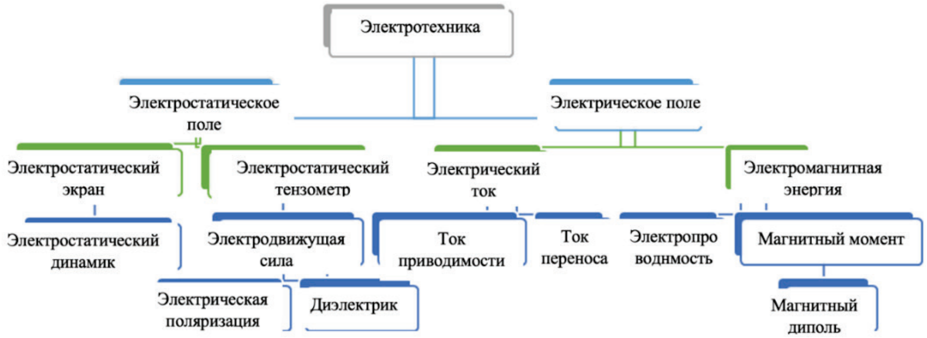

Figure 3. Basic frame model of the electrical engineering terminology system in Russian.

Figure 4. Basic frame model of the electrical engineering terminology system in Kazakh.

The frame "Электротехника" should be considered in these languages as a contour of terminology systems that have been formed over many centuries and have acquired a structured form. The analysed frame model displays the complexity of the structure and relationships between frames and subframes. In particular, the structure of the "Электротехника" frame consists of several groups of sub-frames. The concepts of the first level of the model (subframes) are central: "Электроника", "Электротехнологии", "Вычислительные машины", "Автоматы", "Производственные процессы". These frameworks can be used to define a system of scenarios in the field of electrical engineering as accurately as possible. The framework model “Электротехника” is presented as a multi-tiered structure consisting of sub-frames (core concepts), slots (concepts of the first peripheral level) and subslots (concepts of the second peripheral level). In European languages, there is a similarity in the structure of the frame model. Figure 5 shows a frame model of the German terminology system.

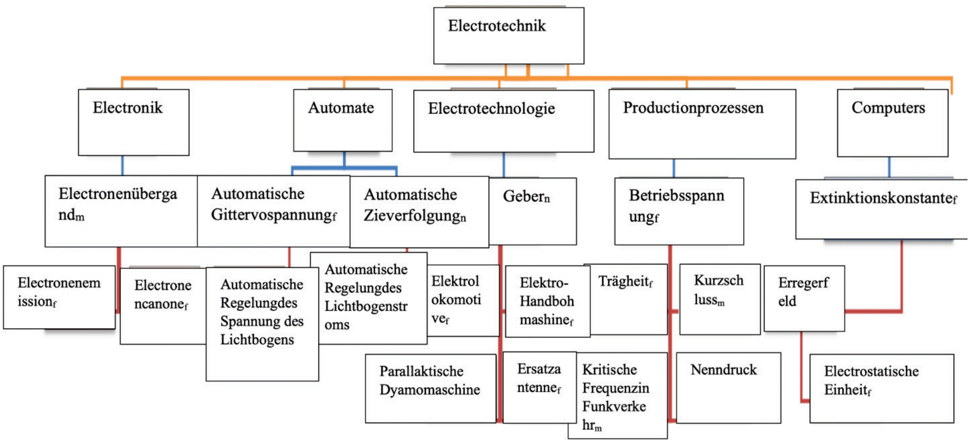

Figure 5. Frame model of the German language terminology system.

The ratio of slots to sub-slots in the frame models of the German and French languages is almost identical. Figure 6 shows the basic frame model of the German language terminosystem. The insignificant lag in the number of slots is not evidence of the backwardness of technical thought in the field of French electrical engineering, but rather due to such a national-linguistic factor as preventing the penetration into the French language of both foreign words and terms in general, which was the main point of the national language policy of the French state long before the establishment of electrical engineering as an official science, i.e., since the 16th century. This fact confirms the authentic linguistic picture of the French language not only in terms of industry terminology but also in terms of the language as a whole.

Figure 7 shows a frame model of the Russian terminology system.

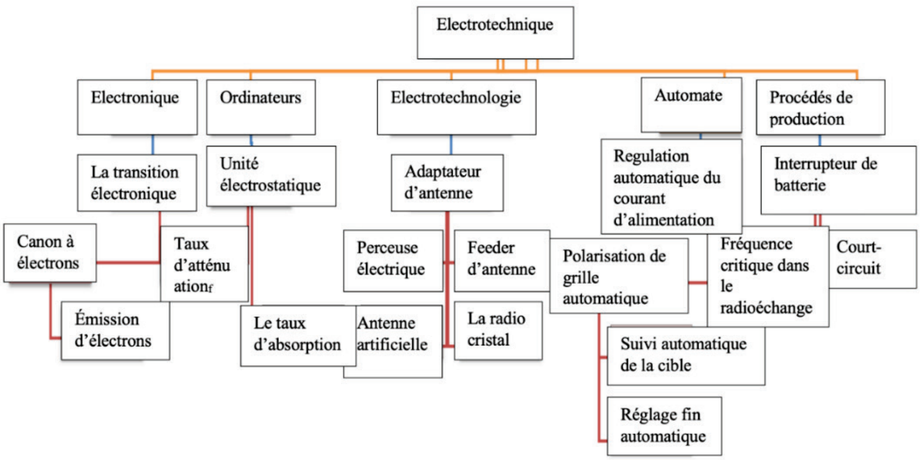

Figure 6. Frame model of the French language terminology system.

Figure 7. Frame model of the Russian language terminology system.

The analysis of the frame model of the Kazakh language terminology system shows that the development of science is directly proportional to the development of the Russian language terminology system, which is due to the extra-linguistic factor of the development of science and technology as a field of specialised knowledge within a single territorial community in the era of the Union of Soviet Socialist Republics, and now - within the Commonwealth of Independent States. Nevertheless, the frame model of the Kazakh language is structured by 5 subframes and 9 sub-slots. This difference in the structural models of the Russian and Kazakh languages is due to the typology of the Kazakh language itself, which belongs to the group of agglutinative languages. Figure 8 shows a frame model of the Kazakh terminology system.

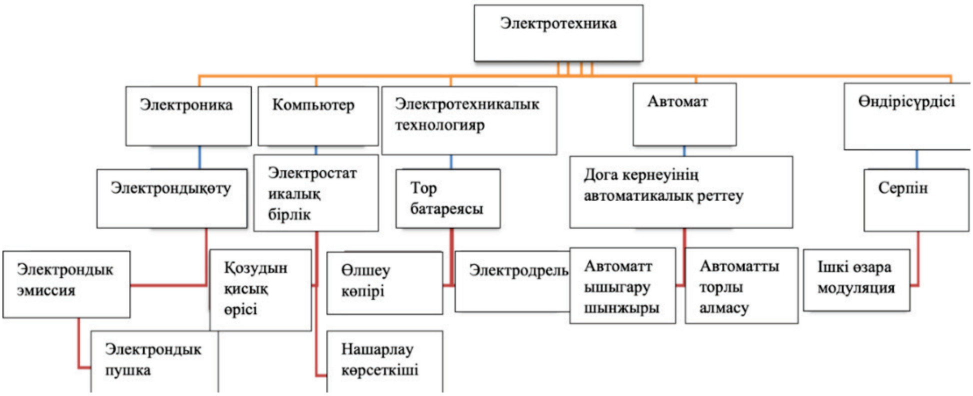

Figure 8. Frame model of the Kazakh language terminology system.

The analysed sub-frames reflect technological processes, units of measurement used in the field of electrical engineering, physical phenomena and equipment. The subframes nominating the main processes and phenomena and characterising the terminosystems of the languages under consideration are characterised by stability and are similar in all the languages under consideration, while differences are observed at the level of slots and sub-slots. The discussed quantitative characterisation of specific frame patterns is presented below, providing evidence of the gradation in the importance of frames in a particular language. The analysis of the frames of the German, French, Kazakh and Russian terminology systems can be used to identify certain trends. Table 1 presents the quantitative characteristics of frames in differently structured languages.

The large number of terminological phrases (23.5%) related to the frame “Die Hochspannungstechnik” in the German terminology system is explained by the high level of development of voltage-related terminology and the parallel surge of discoveries in the electrical engineering terminology. The frame model for the German language is shown in Figure 9. Examples of phrases related to the frame: “Die Hochspannungstechnik”: “Dielektrika”, “Energieversorgung”, “Prüftechnik”, “Isolierwerkstoffe”, “Hochspannungsgleichstromübertragung”, “Elektrische Festigkeit”. Examples of terminological phrases included in the group include “Die Elemente der Overhead und Kabelleitungen”: “Stromführende Ader”, “Gürtelisolation”, “Schutzmantel”, “Schutzhülle”, “Außenmantel”, “Schirmspannungsbegrenzer”. The frame “Das elektrisches Gerät” is represented by such terminological phrases as “Hilfsstromaggregat”, “Motorschutz-Thermistorrelais”, “Leistungskondensator”, “Strommessrelais”. And the “Physikalische Phänomene” frame is represented by such terminological combinations as “Elektrogerät”, “Elektrische Zugvorrichtungen”, “Elektrisches Schaltgerät”.

Table 1. Quantitative Characterisation of German, French, Kazakh and Russian Frames.

Frames of the German terminology system (number of terms)	**Frames of the French terminology system (number of terms)**	**Frames of the Russian terminology system (number of terms)**	**Frames of the Kazakh terminology system (number of terms)**
Die Hochspannungstechnik, 542 TP≈23.5%	Technologie de haute tension, 528 TC≈23%	Техника высокого напряжения, 418 TP≈18.1%	Жоғары кернеулі технологиясы, 418 TP≈18.2%
Die Elektrische Maschinen, 254 TP≈11.1%	Machines électriques, 260 TP≈11.2%	Электрические машин, 273 TP≈11.9%	Электрикалық машиналары, 286 TP≈12.4%
Das elektrisches Gerät, 275 TP≈12%	Appareils électriques, 258 TP≈11.2%	Аппараты, 321 TP≈14%	Приборлар, 320 TP≈13.9%
Der Elektroantrieb, 201 TP≈8.8%	L’entraînement électrique, 258 TP≈11.2%	Электропривод, 300 TP≈13%	Электржетегі, 300 TP≈13%
Die Elemente der Overhead und Kabelleitungen, 468 TP≈20.3%	Des éléments d’aériens et câbles de lignes, 458 TP≈19.9%	Элементы воздушных и кабельных линий, 453 TP≈19.7%	Әуелік және кабельдік желілер элементтері, 452 TP≈19.6%
Physikalische Phänomene, 305 TP≈13.2%	Les phénomènes physiques, 289 TP≈12.6%	Физические явления, 302 TP≈13.1%	Физикалық құбылыстар, 296 TP≈12.9%
Die Instrumentenausrüstung, 257 TP≈11.1%	Appareillages de mésure, 251 TP≈10.9%	Измерительные приборы, 235 TP≈10.2%	Өлшеуге арналған аспаптар, 230 TP≈10%

Note: TP – terminological phrases; % ratio is given of the total number of selected terminological phrases: in total – 2302 for each terminology system, 9208 in total.

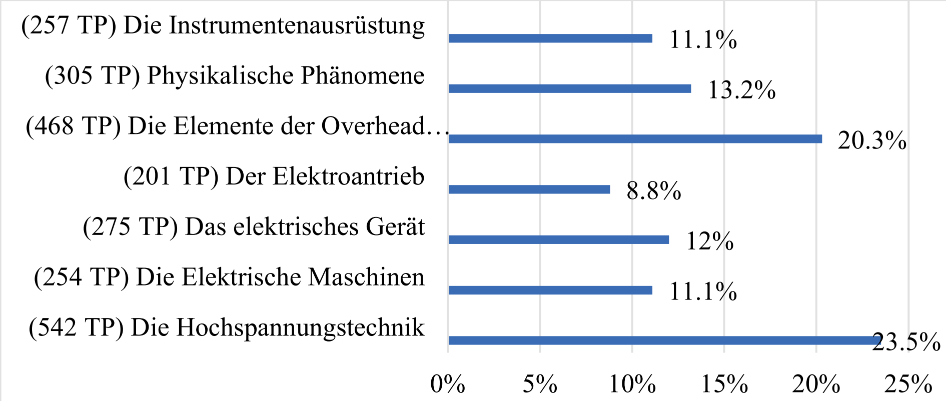

Figure 9. Frame modelling of the German terminology system.

The frame model for French with subframes, slots and sub-slots is presented in Figure 10. Examples of terminological phrases related to the Technologie de haute tension" frame: "Transformateur élévateur", "Fiabilité d'alimentation en énergie électrique", "Transmission par courant continu", "Isolants pour cables". Among the terminological phrases that make up the frame "Des éléments d' aériens et câbles de lignes" are the following: "Bras d'armement", "Câble protecteur", "Câble de garde", "Paratonnerre", "Terre-Neutre-Combine", "Borne de mise à la terre". Terminology phrases related to the frame "Les phénomènes physiques": "Effet de superconductibilité", "Tension de radiation", "Admittance négative", "Électroluminescence".

When analysing the Russian language frames, it was found that the terminological word combinations in the Russian language, united by the frames "Техника высокого напряжения" and "Измерительные приборы", as well as in the word combinations in the Kazakh language, united by the frames "Жоғары кернеулі технологиясы" and "Өлшеуге арналған аспаптар", had lower indicators compared to European languages. The frame model for Russian with subframes, slots and sub-slots is shown in Figure 11. Examples of terminological phrases included in the frame "Элементы воздушных и кабельных линий": "Провода", "Арматура", "Изоляторы", "Грозозащитные тросы", "Заземляющие устройства", "Разрядники". Among the terminological phrases that are related to the "Техника высокого напряжения" frame: "Токоведущие компоненты", "Заземленные конструкции", "Высокое постоянное напряжение", "Емкостные накопители энергии". The "Электропривод" frame is represented by such terminology as "Электропривод вентиляции", "Электропривод линейного действия", "Реечный электропривод", "Гидроприжим".

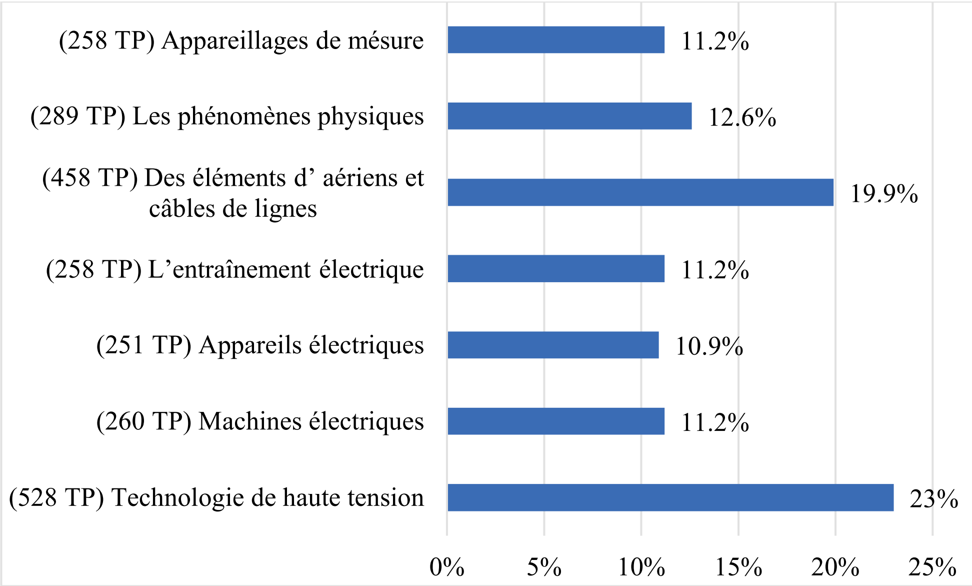

Figure 10. Frame modelling of the French terminology system.

Figure 11. Frame modelling of the Russian terminology system.

It demonstrates the smooth, progressive development of the Kazakh terminology system in the field of specialised knowledge.

Figure 12. Frame modelling of the Kazakh terminology system

In this paper showed that the terminology systems of the Russian and Kazakh languages demonstrated a high level of growth in the field of electrical hardware modelling. is due to both cognitive and extra-linguistic factors. “Жоғары кернеулі технологиясы”: “Жоғары вольтты катушканың”, “Тұрақты ток көздеріне”, “Оқшаулау жабыны”, “Күшейткіш трансформатор”. Among the phrases, related to the frame “Әуелік және кабельдік желілер элементтері”, are the following: “Найзағайдан қорғайтын”, “Оқшаулағыштар”, “Жермен қосу”, “Іргелес электрлік сымдар”.

Thus, the presented frames of the electrical engineering terminology system in differently structured languages confirm the existence of different ways of explicating the cognitive knowledge of the terminosphere in the subject area of electrical engineering. The mental perception of electrical engineering terminology by native Russian and Kazakh speakers is different from that of native German and French speakers (Efremov, 2025a; Ivanova and Martyniuk, 2024). This provoked the historically recorded untimely “patenting” of several inventions and discoveries, which led to a natural “outflow” of terms into the terminology of European languages, for example, German. It should be noted that the frame models presented in this study showed insignificant quantitative differences in slots and sub-slots, the most developed in this context being the German language terminology. It is represented by 5 sub-frames, 6 slots and 14 sub-slots. The frame models developed in this study demonstrated a high degree of similarity between German and French, as well as between Russian and Kazakh. Moreover, the terminosystems of the considered multistructured languages demonstrate differences in terms of frequency between different categories of terminological phrases.

4. Discussion

This study set out to show how frame semantics and conceptual modelling can jointly clarify the structure of electrical engineering terminology in German, French, Russian and Kazakh. By decomposing every term into frames, slots and subslots and then validating the hierarchy against space, time and usage constraints, the work followed the modelling principles of applicability and code verification outlined by Refsgaard and Henriksen (2004). The resulting inventory confirms Löbner's (2021) argument that deep lexical decomposition reveals hidden relations that simpler taxonomies obscure. It also operationalises the verb–noun alignment strategy proposed by Koeva and Doychev (2022) and therefore strengthens the claim that conceptual frames offer a transferable scaffold for multilingual terminology.

When the frequency data were compared across languages, clear historical and technological patterns emerged. High-voltage terminology dominates German and French corpora, consistent with the prominence of these traditions in early power engineering, whereas units related to overhead and cable lines are more frequent in Russian and Kazakh, echoing the Soviet era focus on transmission infrastructure. These asymmetries extend the descriptive work of Zheng (2020) and León-Araúz et al. (2020) by showing that they persist even after normalising for corpus size and genre. The robust clustering of two- and three-component terms across all four languages supports Saeed and Naveed's (2022) finding that compound structures remain productive in specialised vocabulary, but our data further suggest that compounds are less opaque when embedded in a frame model that exposes their internal roles.

The model also engages directly with current efforts to automate terminological resources. Ontology driven databases depend on accurate concept hierarchies, and Madsen and Thomsen (2009) demonstrated that data models degrade when the underlying terminology is inconsistent. Because the present hierarchy is fully explicit it can serve as a ready made backbone for conceptual data models in smart grid management, power electronics and similar domains. In artificial-intelligence pipelines the slot and subslot labels can feed neural encoders to improve disambiguation, a benefit anticipated by Guo et al. (2021). Multimodal extensions are equally feasible. The image aligned sensemaking framework of Ciroku et al. (2024) could attach diagrams of circuit components to the relevant slots, while the multimodal context representation proposed by Torrent et al. (2022) would allow parallel alignment of text, schematic and audiovisual documentation.

Machine translation is another application area. Neural systems often mistranslate technical polysemes or leave compounds untranslated; explicit frame tags can act as constraints during decoding, in line with the multilayer annotation strategy reported by Amspoker and Petruck (2022). The contextual analysis of San Martin (2022) showed that precise thematic and cultural cues improve term definitions; our cross-linguistic slot mapping supplies those cues directly to translation memory and terminology management tools. Moreover, the model can be used to discover gaps in national databases, supporting the gap-filling procedures outlined by Massion (2021) for AI-assisted terminology work.

The construction process also demonstrated that frame semantics can be systematically linked to ontological and contextual information. Molina Salinas et al. (2020) used source documentation to differentiate term senses; by incorporating comparable documentation in four languages, the present study creates a richer multilingual profile. Where dynamic processes were under-represented, as noted for change-of-state verbs by Herweg (2021), phase lattices could be inserted in later versions to capture temporal stages of electrical events such as charging, discharging and fault clearance.

Several limitations remain. The corpus relied primarily on published literature and standards, so emergent terminology from social media, grey literature or real-time sensor output was not captured. Visual data were included only at a pilot level despite the proven value of diagrammatic cues (L'Homme & Robichaud, 2014; Nurgaliyeva et al., 2025). Future work should integrate larger image repositories and adopt the AI based retrieval pipeline sketched by Massion (2021). Dynamic slots should also be expanded to reflect event-based descriptions, which will improve compatibility with the event extraction models advocated by Herweg (2021).

Even with these caveats, the study demonstrates that a carefully validated frame model can bridge linguistic diversity and technical precision. By linking term frequency, semantic role structure and ontological alignment, the model provides a replicable template for designing multilingual terminologies, training domain specific machine translation engines and structuring engineering databases. In doing so, it responds to the call for data driven terminology resources that can scale across languages, media and applications (Vezzani & Di Nunzio, 2023) while remaining conceptually transparent and empirically grounded.

5. Conclusions

Using frame analysis, this study modelled frame structures in the field of electrical engineering based on German, French, Kazakh and Russian. The analysis of the basic frame models of the electrical engineering terminology system confirmed the following theses. Firstly, the model under consideration is structured with the help of a core (frames, subframes) and a peripheral area (slots and sub-slots), which characterise the specifics of cognitive modelling in multi-structured languages. Secondly, the study determined that the reflection of the structure of knowledge in the electrical field of activity allows us to present the national specificity of the linguistic consciousness of German, French, Russian and Kazakh speakers. The limitations of this study are primarily related to the number of terminological phrases in the field of electrical engineering (about 9208 terminological phrases were analysed, 2302 for each terminosystem).

In the languages under consideration, there are the same number of frames and subframes representing the core of the frame model. The difference in frame models was observed on the periphery, namely at the level of slots and sub-slots. The analysis of the illustrative material demonstrated the expansion of the frame model in the peripheral area: 6 slots and 14 sub-slots in German, 5 slots and 13 sub-slots in French, 6 slots and 10 sub-slots in Russian and 5 slots and 9 sub-slots in Kazakh. The smaller number of slots in the frame model of the Kazakh language terminology system is explained historically, in particular by the types of activities that have influenced the terminology in the field of electrical engineering, which is fixed in the linguistic consciousness of Kazakh speakers, the stability of verbalised forms of Russian-language frames in the linguistic consciousness of the Kazakh people and the absence of indigenous Kazakh terms in several frames.

The ratio between the considered frames in the terminology of German and French is approximately the same: “Die Hochspannungstechnik” (23.5%), “Technologie de haute tension” (23%), “Die Elemente der Overhead und Kabelleitungen” (20.3%), “Des éléments d’ aériens et câbles de lignes” (19.9%), “Die Elektrische Maschinen” (11.1%), “Machines électriques” (11.2%). The study also determined that German and French have the highest number of terminological phrases for high-voltage equipment, while Russian and Kazakh have the largest group of frames related to elements of overhead and cable lines. In general, the number of frames in Russian and Kazakh is several percent lower than in German and French.

Based on the constructed frame models in multi-structured languages in this study, it is possible to conclude that due to the promising development of the cognitive aspect in the field of electrical engineering, there is a gradual increase in new subframes, as well as slots and sub-slots. In the future, the construction of frame models can be developed in the direction of automating the selection of terminological phrases for their further cognitive analysis, considering lexical, semantic and structural features. Another important area is research related to the development of frame models in different languages in languages that are little studied or insufficiently studied.

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