

RESEARCH ARTICLE

Cognitive Analysis of Information Technology Terms in Translation

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VOLUME: Vol.06 Issue10 2026

PAGE: 01-07

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Abstract

The rapid expansion of information technology has intensified the need for accurate, conceptually consistent, and cognitively grounded translation of specialized terminology. Conventional term-to-term translation is frequently insufficient because information technology (IT) terms encode not only lexical meanings but also relations among processes, functions, entities, users, tools, and technical contexts. This research examines the cognitive structure of IT terminology in translation through a frame-oriented analytical perspective. The study develops a conceptual framework connecting specialized terms, knowledge structures, semantic frames, contextual relations, and translation equivalence. The methodology is qualitative and analytical, based exclusively on the provided literature concerning frame semantics, terminology, specialized knowledge representation, computational terminology, and translation. Particular attention is given to the distinction between lexical equivalence and conceptual equivalence and to the role of contextual and relational information in translating IT terminology. The analysis indicates that frame-based modelling provides a stronger explanatory mechanism for IT terminology than isolated lexical correspondence because it represents the knowledge structures activated by specialized terms. The study further demonstrates that terminology resources and computational tools can benefit from integrating frame relations and contextual information. The resulting model contributes to translation-oriented terminology research by combining cognitive analysis with terminological representation and offering a structured basis for improving consistency, interpretability, and functional adequacy in IT translation.

KEY WORDS

Information technology terminology, cognitive analysis, translation, frame semantics, terminology modelling, conceptual representation, translation equivalence, specialized knowledge, computational terminology.

1. INTRODUCTION

Information technology has generated a rapidly expanding body of specialized terminology encompassing software, hardware, digital processes, computational functions, interfaces, data structures, and technological operations. Translating this terminology presents a problem that extends beyond the identification of lexical equivalents. A technical

term generally refers to a specialized concept embedded in a broader knowledge system, and its interpretation may depend on the entities, processes, functions, and relations associated with that concept. Consequently, translation accuracy requires attention to the conceptual structure underlying terminology rather than only to the surface form of individual lexical units.

The relationship between terminology and knowledge representation is particularly important in this context. Faber and Cabezas-García (2019) conceptualize specialized knowledge representation through the relationship between terms and frames, emphasizing that terms can be understood as access points to structured knowledge. Similarly, L'Homme (2018) highlights the necessity of maintaining an appropriate balance between lexical information and specialized knowledge in terminology. These perspectives indicate that a term cannot always be adequately represented as an isolated dictionary entry.

The cognitive dimension becomes even more significant in translation. Bondarenko (2022) demonstrates the relevance of frame interpretation to translation, while Hamamoto (2023) shows that translation equivalence can become problematic when culturally or conceptually specific knowledge must be reconstructed in a target language. For IT terminology, such difficulties can arise when two languages lexicalize technological processes differently or when a target-language equivalent does not reproduce the same conceptual relations as the source term.

Technical terminology also exists within practical documentation and computational environments. The Blender Translate resource illustrates the practical importance of terminology within the translation of specialized technical documentation, where consistency and contextual appropriateness are essential for users interacting with software-related content (Blender Translate, n.d.). Thus, terminology translation must address both conceptual representation and functional communication.

The objective of this research is to develop a cognitive analytical framework for examining IT terms in translation. The study specifically investigates how specialized terms activate conceptual frames, how frame relations influence translation equivalence, and how terminology resources can incorporate cognitive information. Its significance lies in establishing a systematic connection between cognitive modelling, specialized terminology, and translation practice.

2. LITERATURE REVIEW

The literature provided establishes several interconnected foundations for analysing IT terminology from a cognitive and translation-oriented perspective. The first concerns the representation of specialized knowledge. Faber and Cabezas-García (2019) argue for a representation of specialized

knowledge that connects terms with frames. This approach changes the analytical status of a term: instead of treating it simply as a lexical label, it can be viewed as an entry point into a structured conceptual domain. For IT terminology, this distinction is essential because terms frequently represent actions, processes, objects, states, and relationships that cannot be fully understood independently.

L'Homme (2018) similarly addresses the relationship between knowledge and the lexicon in terminology. The central implication for translation is that terminological resources must preserve both lexical information and the specialized knowledge associated with a term. A translator working with a term describing a computational process, for example, may require information about the process itself, its participants, its input and output, and its relationship to other processes. A purely bilingual dictionary equivalent may therefore be inadequate.

The frame-based approach is further developed through lexicographic and computational perspectives. Giacomini (2018) examines the presentation of multiword terms through frame-based lexicography, indicating that complex terminology can be organized according to structured semantic information. Giacomini and Schäfer (2020) extend this perspective to computational aspects of frame-based meaning representation in terminology. Their work is particularly relevant to IT translation because computational terminology systems require formalized relations that can support machine-readable representation and retrieval.

Translation itself constitutes another major dimension of the literature. Bondarenko (2022) examines frame interpretation in translation and demonstrates the relevance of frame-based analysis to the reconstruction of meaning across languages. This is consistent with the broader proposition that translation should preserve conceptual relations rather than merely substitute lexical forms. Faber and Reimerink (2019), although focusing on legal translation, provide additional evidence that terminology can be understood through framing. Their study demonstrates that framing terminology allows specialized meanings to be interpreted through structured contextual relations.

Czulo et al. (2019) introduce a framesemantic perspective to machine translation evaluation. Their work is significant because it shifts attention from simple textual correspondence toward the evaluation of semantic structures. In the context of IT terminology, this suggests that translation quality can be

assessed according to whether relevant conceptual relations have been retained.

Hamamoto (2023) approaches translation equivalence through culturally specific concepts. Although the study is not restricted to IT, its theoretical implications are applicable to technical terminology because specialized concepts may also be structured differently across linguistic communities. Translation equivalence should therefore be examined at the conceptual and functional levels rather than assumed from lexical similarity.

Other provided studies reinforce the computational and terminological dimensions. Liu (2025) addresses automatic term dictionary extraction using BiLSTM, illustrating the growing role of computational techniques in terminology management. Hitcheva (2025) examines terminological verb collocations, demonstrating that terminological meaning can also depend on recurrent lexical combinations rather than isolated terms. Maslova and Fedorenko (2022) explicitly position cognitive approaches as relevant to interdisciplinary terminology research.

Hinrichs et al. (2022), through their discussion of embodied metarepresentations, provide an additional cognitive perspective on how representations can be constructed and interpreted. While their research is not specifically concerned with IT translation, it supports consideration of representation as an interpretive process rather than merely a static linguistic structure.

The literature reveals a clear research gap. Existing studies separately address frame interpretation, terminology, specialized knowledge representation, computational terminology, and translation equivalence. However, a focused framework for analysing IT terminology in translation through the combined dimensions of cognitive frames, lexical representation, contextual relations, and translation functionality remains underdeveloped within the provided literature. The present study addresses this gap by integrating these dimensions into a unified analytical model.

3. METHODOLOGY

3.1 Research Design

The study adopts a qualitative conceptual research design based on analytical synthesis of the provided literature. No external sources are introduced. The methodology is designed to identify common theoretical principles across terminology

studies, frame-based approaches, cognitive research, computational representation, and translation studies.

The analytical unit is the IT term considered within its linguistic and conceptual context. Rather than examining a term as an isolated lexical item, the analysis considers five interconnected dimensions: lexical form, conceptual function, frame structure, contextual relations, and translation realization. This design follows the principle that specialized terminology represents knowledge structures rather than independent words (Faber & Cabezas-García, 2019).

3.2 Cognitive-Frame Model

The proposed model represents an IT term as an activation point within a conceptual frame. A frame can be understood as a structured configuration of knowledge containing a central concept and associated roles. In an IT environment, a process-oriented term may activate roles corresponding to an actor, operation, technological object, input, output, instrument, and purpose.

For example, a hypothetical term such as data encryption should not be represented only through a target-language lexical equivalent. Its conceptual frame may include an encryption operation, data as the affected entity, an encryption mechanism, a key, a responsible user or system, and a security-related purpose. A translation that reproduces the lexical label while altering one of these relations may remain formally similar but conceptually inaccurate.

The proposed frame can therefore be expressed as:

IT Term → Concept → Frame → Relations → Target-Language Realization

The first component identifies the lexical unit. The second identifies the specialized concept activated by the term. The third establishes the knowledge frame. The fourth identifies semantic and functional relations within that frame. The final component determines how the conceptual structure is realized in the target language.

This model extends the term-to-frame relationship discussed by Faber and Cabezas-García (2019) and connects it with frame-based translation analysis proposed by Bondarenko (2022).

3.3 Lexical and Conceptual Analysis

The next methodological stage distinguishes lexical equivalence from conceptual equivalence. Lexical equivalence

occurs when source and target languages provide corresponding expressions. Conceptual equivalence requires a stronger condition: the target expression must activate an appropriately corresponding conceptual structure.

Consider a hypothetical IT term referring to a user authentication process. A target-language expression may be lexically acceptable but conceptually incomplete if it fails to preserve the distinction between the user, authentication mechanism, credentials, and verification process. The analysis therefore asks whether the target term activates the same essential frame elements.

This approach is consistent with L'Homme's (2018) observation concerning the relationship between terminology and specialized knowledge. It also complements Hamamoto's (2023) discussion of translation equivalence, in which equivalence cannot be reduced to straightforward lexical substitution.

3.4 Contextual and Collocational Analysis

IT terminology frequently occurs in recurrent combinations. A term's interpretation can therefore depend on neighboring lexical units and its syntactic environment. Hitcheva (2025) demonstrates the relevance of terminological verb collocations to translation problems, suggesting that translation analysis should consider the behaviour of terms in context.

For example, the hypothetical term *deploy a model* differs conceptually from a generic use of *model*. The verb *deploy* activates a technological process involving implementation or operational use. Consequently, a terminology system that records only the noun without its typical collocations may provide insufficient information for accurate translation.

Giacomini's (2018) frame-based lexicographic approach is relevant here because multiword terms can be represented through richer semantic structures. The methodology therefore treats collocation as an important indicator of frame activation.

3.5 Computational Representation

A computational extension of the model can represent each term as a node connected to frame elements and semantic relations. The resulting structure could include relations such as *performs*, *acts-on*, *requires*, *produces*, *controls*, *contains*, and *supports*.

Giacomini and Schäfer (2020) provide a foundation for considering computational representation of frame-based

meaning in terminology. Liu (2025), meanwhile, demonstrates the relevance of automated extraction techniques to term-dictionary construction. Combining these perspectives suggests a potential workflow in which computational systems first identify candidate IT terms and then enrich them with frame-level information.

Blender Translate provides a practical example of the environment in which such terminology management becomes consequential: technical translation within software documentation requires terminology to remain understandable and consistent across translated material (Blender Translate, n.d.).

3.6 Translation Evaluation

The final methodological component evaluates translation at three levels: lexical, conceptual, and functional. Lexical evaluation asks whether the target expression corresponds appropriately to the source term. Conceptual evaluation asks whether the relevant frame and its essential relations are preserved. Functional evaluation asks whether the translated term performs the same communicative and technical function for the target user.

This three-level model is compatible with the framesemantic evaluation perspective discussed by Czulo et al. (2019). It also accommodates the possibility that a translation may be lexically different but conceptually and functionally superior. Therefore, translation quality should not be measured exclusively through surface similarity.

4. RESULTS

The analysis identifies four principal findings concerning the cognitive treatment of IT terminology in translation.

First, IT terms function as conceptual access points rather than isolated lexical units. The literature consistently supports the interpretation of specialized terminology as connected to knowledge structures. Faber and Cabezas-García (2019) establish the relationship between terms and frames, while L'Homme (2018) emphasizes the need to maintain a balance between lexical and knowledge-based information. Consequently, a cognitive model of IT terminology should associate each term with its conceptual domain and relevant relations.

Second, frame structure provides a more precise basis for distinguishing lexical equivalence from conceptual equivalence. A translation can contain an apparently

appropriate target-language term while failing to reproduce an essential relation within the source concept. Bondarenko (2022) demonstrates the importance of frame interpretation in translation, and Hamamoto (2023) reinforces the broader problem of reconstructing conceptual meaning across languages. The present synthesis indicates that translation assessment should therefore examine which frame elements are retained, transformed, or omitted.

Third, contextual information is indispensable for technical terminology. Giacomini (2018) and Hitcheva (2025) demonstrate the importance of multiword structures and terminological collocations. In IT discourse, terms frequently obtain operational meaning through their relationships with verbs, modifiers, processes, and technological objects. A translation system that stores only isolated bilingual equivalents is consequently limited in its ability to resolve context-dependent terminology.

Fourth, computational terminology management can benefit from cognitive enrichment. Giacomini and Schäfer (2020) provide a basis for computational frame representation, while Liu (2025) demonstrates the potential of automatic terminology extraction. The synthesis suggests that automated extraction should be complemented by conceptual classification. A system capable of identifying a term but unable to identify the frame it activates may reproduce lexical information without adequately representing specialized knowledge.

The findings also indicate that practical technical translation environments require consistency as well as conceptual accuracy. Software documentation, represented by the Blender Translate context, illustrates the need for terminology to function consistently across technical texts (Blender Translate, n.d.). Repeated use of a term in different contexts requires a terminology model capable of distinguishing legitimate contextual variation from inconsistent translation.

Overall, the proposed cognitive model indicates that effective IT terminology translation requires integration across four layers: lexical identification, conceptual framing, contextual interpretation, and target-language realization. This layered structure offers a more comprehensive analytical basis than direct word-level substitution.

5. DISCUSSION

The findings have significant theoretical implications for terminology and translation research. The central implication

is that IT terminology should be understood as a knowledge representation problem as well as a linguistic problem. Traditional term equivalence assumes that the primary task is to identify a corresponding lexical expression. The cognitive perspective developed here instead asks what knowledge structure is activated by the term and whether that structure is appropriately reconstructed in translation.

This position strengthens the term-to-frame relationship proposed by Faber and Cabezas-García (2019). If terms function as access points to specialized knowledge, translation requires the translator to move between conceptual structures rather than simply between words. The frame therefore becomes an intermediate analytical layer connecting source terminology and target terminology.

The findings also support the importance of contextual representation. Giacomini (2018) demonstrates the relevance of frame-based lexicography for multiword terms, while Hitcheva (2025) highlights the translation significance of terminological verb collocations. These studies imply that a terminological entry should ideally contain contextual and relational information. For IT terminology, such enrichment is particularly important because technological processes are frequently expressed through combinations such as noun-verb constructions, compound terms, and process descriptions.

A further implication concerns computational translation. Giacomini and Schäfer (2020) show the relevance of computational frame-based meaning representation, while Liu (2025) demonstrates the applicability of automated term extraction. The present framework suggests that these computational approaches should be integrated rather than treated as independent stages. Automatic term extraction can identify candidate terminology, but cognitive modelling can provide the conceptual relations needed to interpret and translate those terms.

The approach also introduces an important trade-off. Greater conceptual detail can improve translation precision but may increase the complexity and resource requirements of terminology systems. A basic bilingual dictionary is easier to maintain, whereas a frame-enriched terminology database requires systematic identification of participants, relations, contexts, and conceptual distinctions. This creates a practical tension between computational efficiency and representational richness.

Another limitation concerns the variability of conceptual

structures across languages and domains. Hamamoto (2023) demonstrates that equivalence can become difficult when conceptual structures do not map directly between languages. Although IT terminology is often highly internationalized, technical concepts are not necessarily lexicalized identically across languages. Therefore, the proposed framework should not assume universal one-to-one correspondence between frames and lexical expressions.

The framework is also compatible with the evaluation perspective of Czulo et al. (2019), which emphasizes framesemantic dimensions in translation evaluation. However, frame-based evaluation itself depends on the accurate identification of relevant frame elements. Incorrect or incomplete frame construction could therefore reproduce analytical errors at a higher conceptual level.

Finally, the practical relevance of the framework is demonstrated by technical translation environments such as Blender Translate, where terminology consistency is directly connected with the usability of translated software documentation (Blender Translate, n.d.). A cognitively enriched terminology resource could assist translators by showing not only equivalent terms but also their conceptual relationships and appropriate contexts.

Despite these advantages, the present study remains conceptual rather than experimentally validated. It does not employ a statistically measured IT terminology corpus or compare human and machine translation outputs. Future empirical research should therefore test the proposed framework against multilingual IT corpora and evaluate whether frame-enriched terminology resources improve translation consistency, semantic accuracy, and user comprehension.

6. CONCLUSION

This study has examined the translation of information technology terminology through a cognitive and frame-based perspective. The analysis demonstrates that IT terms should not be treated exclusively as lexical units because their meanings are embedded in specialized conceptual structures. Frame-based modelling provides a mechanism for representing these structures and for distinguishing lexical equivalence from conceptual and functional equivalence.

The proposed model integrates five analytical components: lexical form, concept, frame, contextual relations, and target-language realization. It further establishes three evaluation

levels—lexical, conceptual, and functional—that can provide a stronger basis for assessing terminology translation. The synthesis of the provided literature indicates that this approach is theoretically supported by research on specialized knowledge representation, frame interpretation, terminology, computational representation, and translation equivalence.

The principal contribution of the study is the integration of these perspectives into a coherent framework specifically applicable to IT terminology. Such a framework can support terminology databases, translator decision-making, technical documentation, and computational translation systems. In particular, the integration of automatic term extraction with frame-based conceptual enrichment offers a promising direction for future terminology technologies.

The practical application of the model also suggests that technical translation environments require terminology management that combines consistency with conceptual flexibility. As demonstrated by the relevance of software translation environments such as Blender Translate, terminology must remain functionally meaningful for users while preserving specialized knowledge across languages (Blender Translate, n.d.).

Future research should empirically validate the proposed framework through multilingual IT corpora, human translation experiments, and computational evaluation. Particular attention should be given to frame identification, terminological collocations, automated conceptual classification, and the measurement of translation quality at lexical, conceptual, and functional levels. Such research could further establish cognitive terminology modelling as an effective foundation for increasingly complex multilingual IT communication.

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