

## Advancing Translation Practice: A Comprehensive Review and Classification

### of Translation Technology Tools

**Dr.Ahmed Nouredine BELARBI \***

Kasdi merbah Ouargla

blrbhmd@gmail.com

**Dr.Mohammed Chouchani Abidi \***

University of Shahid Hamma Lakhdar - El Oued (Algeria).

mohammed-chouchaniabidi@univ-eloued.dz

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**\*Corresponding Author**

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### Abstract:

Translation technology, integral to modern translation, enhances the efficiency of professional translators. Amidst the growing demand for high-quality translation services, understanding and categorizing diverse computer tools are imperative. This paper presents a comprehensive review and classification of professional translation tools, exploring Melby's, Vilarnau's, and Neunzig's categorizations. Melby's approach considers translation stages, terminological, and segmental levels, offering insights into technology applications. Vilarnau's five-category classification based on program relationships is analyzed, revealing varied relevance in translation tasks. Incorporating Neunzig's three-dimensional approach, the study underscores tool suitability based on usage, functions, and methods for diverse user profiles. Findings show a historical shift from integrating technology-assisted tools with human translators to prioritizing machine translation for enhanced productivity. Emphasizing the importance of understanding each tool's role, user profile, and translation dimension, this research serves as a valuable resource for practitioners, educators, and researchers, providing a holistic view of tools and applications.

**Keywords :** classification , computer tools ,professional translation ,translation practice ,translation technology

Maalim

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## Introduction

Translation technology has revolutionized the world of translation, playing a pivotal role in enhancing the efficiency and accuracy of professional translators. As the demand for top-notch translation services continues to soar, the integration of computer tools has become indispensable. This research paper aims to provide a comprehensive review and classification of the various translation tools employed in professional translation practice.

**Research Questions:** To guide our exploration, this study addresses the following research questions:

1. What are the specific functionalities of different translation tools?

How do these tools cater to the distinct needs of translators at various stages of the translation process?

**Methodology:** Our methodology involves a systematic literature review and categorization of translation tools. We have adopted a comprehensive approach that integrates insights from experts such as Melby, Vilarnau, and Neunzig. This approach allows for a nuanced understanding of the diverse range of computer programs utilized in translation tasks. In conducting our review, we have considered the following key elements:

**Selection Criteria:** We carefully selected sources that provide valuable insights into translation technology and tools.

**Framework for Categorization:** Our categorization is based on established frameworks proposed by Melby, Vilarnau, and Neunzig.

**Literature Review:** To contextualize our study, we present a thorough literature review, highlighting the seminal work of Melby, Vilarnau, and Neunzig in the field of translation technology. This review not only underscores the current state of knowledge but also identifies gaps that our study addresses.

The primary objective of this study is to categorize and analyze translation tools to better understand their specific functionalities and how they cater to the distinct needs of translators. Through an in-depth exploration of different classifications proposed by experts such as Melby, Vilarnau, and Neunzig, we aim to provide valuable insights into the diverse range of

computer programs utilized in translation tasks.

By examining the relationship between technology and translation, we seek to shed light on the crucial role these tools play at various stages of the translation process - from pre-translation to post-translation activities. Furthermore, we will emphasize the significance of these tools in both terminological and segmental aspects of translation work.

Our research endeavors to present a comprehensive perspective on translation technology, encompassing its applications in teaching, professional translation, and translation research. As we explore the different dimensions of translation technology, we will highlight the varying degrees of relevance that these tools possess with respect to translation tasks.

Ultimately, this research paper aims to serve as a valuable resource for translation practitioners, educators, and researchers alike. By gaining a deeper understanding of the available translation tools and their respective applications, readers will be better equipped to navigate the ever-evolving landscape of the fast-paced translation industry.

### 1-Translation Technology

Many researchers and linguists have defined translation based on diverse perspectives that revolve around the goals, nature, practice, and related specializations of translation. This was before the emergence of modern technology and advancements. Consequently, various definitions emerged, either general or more profound, deeply rooted in conceptual frameworks. However, in the digital age, the use of technology has become more prevalent and necessary in the practice and industry of translation. This calls for giving technology a more prominent place in defining translation, reevaluating its practice, and reframing its initial concepts from a more technological standpoint.

According to Lynne Bowker in her book "Computer-Aided Translation Technology: A Practical Introduction," the concept of "Translation Technology" refers to various types of computer-based tools used in the translation process. This definition encompasses general computer tools such as word processors and electronic resources, as well as specific translation tools like corpus analysis tools and terminology management systems (Bowker, 2002, pp. 5-9).

Another more comprehensive definition of the term is provided by the "A Dictionary of Translation Technology," which describes "Translation Technology," " as "a branch of Translation Studies that deals with topics and skills related to translation computing" (Chan, 2004, p. 258). This means that Translation Technology includes both computer-aided translation tools and machine translation tools. From an academic perspective, it is an integral part of Translation Studies, while from a professional standpoint, it is a crucial and fundamental element in the professional training of translators (Chan, 2017).

According to Alcina (2008), Translation Technology is described as a field that studies how to design and adapt strategies, tools, and technological resources that facilitate the work of translators, as well as enhance research and education in this field.

In the words of Salah Hamed Ismail (2010), Translation Technology is the process of extracting meanings or breaking down the text according to its morphological, syntactic, and semantic structures. This allows for the removal of any potential ambiguity and enables the creation of a standardized language that can be used for translating any text, regardless of the source and target languages, to produce a final text with a high level of accuracy.

Indeed, with the influence of technology, it has become necessary to redefine translation from a more technological perspective. As described by Mohamed Didaoui as "Translation from a New Perspective" and expressed by Chan Sin-Wai as "The Technological Turn in Translation," it is evident that translation is now about "transferring from one language to another with the assistance of technology." This places a strong emphasis on using electronic tools or digital devices in the practice of translation (also see: Chan, 2017).

### 1.1 Artificial Intelligence and Computational Linguistics: Exploring the Concepts

The emergence of computers, the internet, and advancements in communication technology has undoubtedly revolutionized the field of translation, giving it entirely new dimensions. This transformation can be largely attributed to a branch of computer science known as Artificial Intelligence (AI), which has also given rise to a new field called Computational Linguistics or "Natural Language Processing," combining language and computer science. But what exactly do we mean by Artificial Intelligence and Computational Linguistics?

### 1.1.1 Artificial Intelligence (AI)

Artificial Intelligence (AI) is a branch of computer science developed to simulate the behavior of neural cells in the human brain using neural networks. AI possesses the ability to learn by example and simulation, making predictions based on the knowledge it acquires (Abiodun et al., 2018).

According to Abiodun (2018), Artificial Intelligence is considered a new science with diverse scientific backgrounds and references. Its primary goal is to understand human intelligence so that computers can "comprehend" human knowledge. Since researchers in human intelligence have succeeded in building successful programs (such as expert systems that mimic human expertise), this has strengthened their belief in investigating the nature and function of human intelligence. AI, with its interdisciplinary nature (combining computer science, psychology, linguistics, mathematics, logic, and philosophy), aims to create artificial models of "human intelligence" to understand all its aspects and levels. Despite being a science that represents a new integrated direction of knowledge, it seeks to build an artificial understanding of human intelligence.

Artificial Intelligence (AI) has been defined by Borkovec (pp. 15-16) from three different perspectives:

**A. Theoretical Artificial Intelligence:** This branch aims to build computational models of intelligence. Researchers in this field seek to answer philosophical questions about the nature of intelligent systems and the suitable types of knowledge patterns for them. The work starts by defining the behavior of the intelligent system and constructing a formal framework for it, which is then compared to natural experiments. This process requires methodologies to represent knowledge within the computer's memory, writing algorithms capable of using this knowledge, constructing reasoning processes, and enabling these systems to store, comprehend, and modify knowledge as needed.

**B. Applied Artificial Intelligence:** Similar to how physicists employ theoretical physics to build new machines, applied AI engineers use models developed by researchers to create computational formats capable of solving complex problems. This has led to the emergence of a new generation of software known as AI systems. Applied AI, as a subfield of information

technology, holds significant economic value in terms of software development to improve human-machine interactions, solve challenging problems with traditional information, and address complex problems faced by large-scale application systems while developing and controlling them simultaneously.

C. Technical Artificial Intelligence: Just as physicists found themselves developing mathematical problems and new measurement units to solve physics problems, AI scientists did the same when they created new programming languages like LISP and PROLOG. These languages facilitated programming AI systems to accommodate high-powered computer machines, capable of engaging in verbal dialogue in natural language.

Through this classification, it becomes evident that AI encompasses a broad and intricate scope of interests, touching upon various scientific and humanistic disciplines. It is worth noting that AI differs from "Machine Intelligence," as Alcina (July 2020) distinguished between the two during a virtual scientific seminar. He defined Machine Intelligence as "the use of human intelligence through data in specific algorithms," while he described Artificial Intelligence as "the intelligent use of data to assist humans." He further explained that humans aspire to make software capable of sensing, thinking, managing, acting, and adapting, allowing machines to evolve over time and think through data and algorithms. This could lead to a genuine revolution in the fields of technology and information.

### 1.2-Language Engineering and Translation Engineering

are fields that have emerged with the proliferation of computer applications focusing on linguistic aspects. This technology incorporates linguistic and computational knowledge to create practical products and engineering disciplines related to language and translation Ali(2000).

**Language Engineering:** also known as Computational Linguistics or Language Technology, is an applied branch that combines linguistic and computer science through the automated processing of natural languages. Omar (2014) It involves the interaction between linguistic language aspects and the technical information side, aiming to allow human-machine interaction using natural language. It focuses on creating technologies that enable computers to comprehend and process human language efficiently. It deals with processing

linguistic data and storing it in electronic chips and vessels based on strict rules and principles. The work of a language engineer involves describing linguistic data and storing it electronically using well-established rules. On the other hand, Machine Translation or Translation Engineering involves programming computers and standardizing the machine for linguistic knowledge using well-known programming languages. It relies on computational models and linguistic databases to facilitate the translation process.

Translation Technology, which encompasses Machine Translation, is a subfield of Language Technology, also referred to as Translation Engineering. It is based on engineering principles and linguistic foundations, and it falls within the broader scope of applied linguistics. Translation Technology aims to bridge the gap between human languages and computers by automating translation processes, such as automated translation, electronic dictionaries, encyclopedias, terminological databases, and more. It relies on various linguistic and computational knowledge, including theoretical linguistics, computational linguistics, computational lexicography, and statistical linguistics.

### 1.3 Natural Language Processing: Nature and Significance

Natural Language Processing (NLP) stands as one of the most crucial steps to be incorporated into all automated applications, with machine translation being among its paramount applications. NLP is concerned with the study of computational aspects of language, whether spoken or written, encompassing linguistic and computational challenges that it encounters. Developing an Arabic language processing system, however, is deemed challenging and intricate due to the difficulty of integrating phonetic, morphological, syntactic, and semantic knowledge within this system (Radia , 2017, p. 38).

**a) "Processing":** This refers to the automated applications on a set of language texts, involving their transformation, modification, and creative utilization. The process is facilitated through the use of techniques and tools from linguistics, artificial intelligence, and modeling. It is essential to differentiate between describing knowledge, which falls under the purview of linguistics, and expressing this knowledge in models using effective techniques and strategies derived from computer science. This, in essence, is the role of computational linguistics (Fares , 2008, p. 13).

**b) "Automated":** This term pertains to those processes that are carried out by machines, in contrast to the processes performed by humans. The computer is the machine utilized for language processing, as it invented the procedures for computational operations and required further development to process linguistic information (Radia, 2017, p. 39).

c) "Natural Language": The term "Natural Languages" refers to human languages prevailing among people, such as Arabic, English, French, and others, both in active use and those that have become extinct. They are called natural because they evolved naturally without any premeditated planning for their rules, terms, phonetic structures, and other elements. Similarly, dialects and sub-languages undergo evolution over the years without conscious planning. Conversely, the presence of the word "natural" in this context implies the existence of other languages that are not natural. These constructed, planned, artificial, or invented languages have their terms and rules defined based on linguistic characteristics before becoming a language in circulation among people. Prominent examples of such languages include programming languages like Java and Python (see: Bachir 2015).

**d) "Automated Processing":** It is a field that focuses on finding computer-based means and methods to process language and break the linguistic barrier between the computer and its users.

Natural Language Processing (NLP) is the process of creating information systems, software, and workstations that automatically analyze written and spoken texts, without human intervention, to assist computer users in solving language-related problems and issues. This includes automated translation programs, terminology management software, spelling and grammar correction tools, automated vocabulary statistics, automatic summarization, automated discourse analysis, and more. Cohen and Verspoor (2013) define Natural Language Processing as "the computerized analysis of linguistic data," meaning that it involves analyzing language data using computational methods: "Natural Language Processing is the analysis of linguistic data, most commonly in the form of textual data such as documents or publications, using computational methods." (Cohen & Verspoor, 2013)

Accordingly, the general objective of Natural Language Processing is to create a representation of the text that adds structure to natural language by leveraging the knowledge

of linguistics. This structure can be syntactic in nature, by analyzing the grammatical relationships between text components, or more semantic by delving into the meaning conveyed by the text.

#### 1.4. Translation Technology Approaches and New Directions

Over the past two decades, the significant interest in Translation Technology has led to a multitude of perspectives and approaches addressing translation technology topics, resulting in an increased number of tools and resources that can be analyzed. Consequently, various orientations and classifications have been studied and analyzed in the field of Translation Technology.

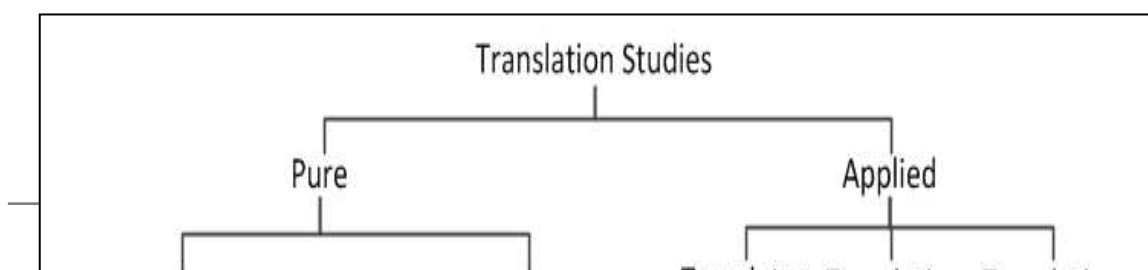
#### 1.5. Initial Approaches to Classifying Translation Technology

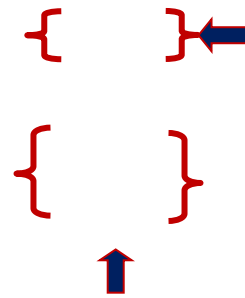
Returning to the early classifications in the field of translation, we find that Translation Studies can be divided into two major categories: theoretical and applied, each of which branches into different subcategories.

Holmes (1988) played a significant role in describing and classifying Translation Studies, paving the way for researchers in the field. His work gave rise to modern schools of thought that explored translation and its issues. He divided Translation Studies into two main branches: pure translation studies, which further divided into theoretical and descriptive translation studies, and applied translation studies. Based on this classification, Translation Studies became an academic field that requires ongoing research, as it evolved into a relatively separate research area, unlike its previous status, where it was considered merely a methodological approach in language teaching.

According to Holmes' model (1988), Translation Technology, previously referred to as "Translation aids," includes dictionaries, grammar rules, and information technology, encompassing translation software, networked databases, and internet resources used in the translation process. All of these fall under applied translation studies, and translation aids are the auxiliary tools derived from this category, as illustrated in the following diagram

Figure 1 illustrating the classification of Translation Technology according to Holmes





**Source: Holmes, J. S. (1988). *The Name and Nature of Translation Studies*. Pp. 67-80**

In the above diagram, Holmes provided a description of the theoretical and applied (practical) branches of Translation Studies. Our current study falls under the applied branch, which includes three important subcategories:

**A) Translator Training:** This category encompasses instructional methods, testing techniques, and curriculum development for translators.

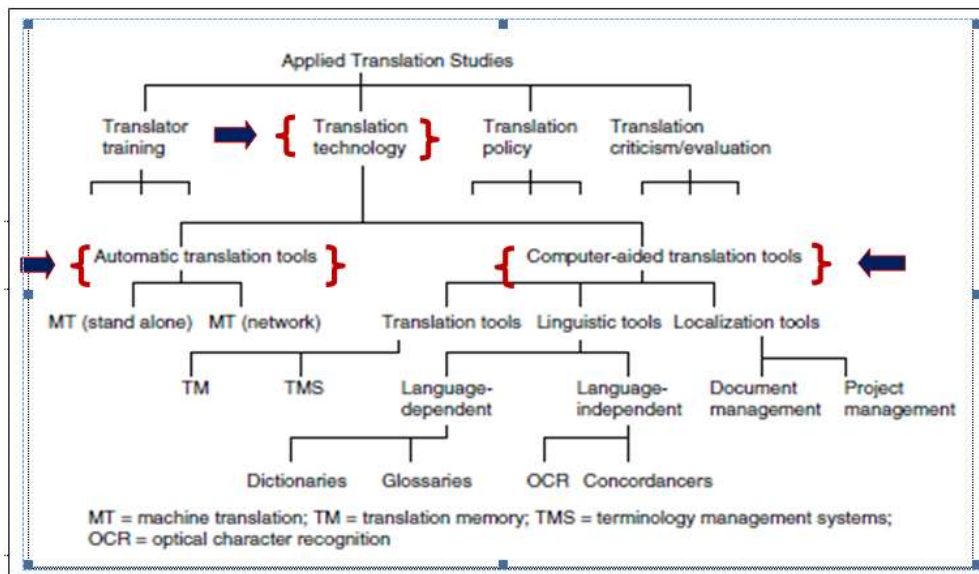
**B) Translation Aids** (which is the subject of the current study): This category includes dictionaries, grammar rules, information technology, and translation software.

**C) Translation Criticism:** This category involves evaluating translations, including assessing students' translations and conducting critical reviews of published translations.

As for Quah's diagram (2006), he used Holmes' classification (Holmes, 1988) as a basis to illustrate and expand on the branches of Translation Technology and its classifications, which were not included in Holmes' original diagram. Through his expanded diagram, Quah provided an overview of the various areas within Translation Technology, making it the most comprehensive classification to date, and it includes our current study.

According to Quah's diagram, Translation Technology is one of the four branches of Applied Translation Studies (as shown in the diagram below), and it further branches into two significant categories: Machine Translation Tools and Computer-Assisted Translation Tools, as illustrated in the following diagram:

**Figure 2 : Quah's diagram**



Source: Quah (2006). *Translation and Technology*. P 42

Based on the above diagram, Translation Technology branches into two main categories:

**Machine Translation Tools:** This category can take two forms: Self-contained Machine Translation and Internet-based Machine Translation.

**2. Computer-Assisted Translation Tools:** This category further branches into three subcategories:

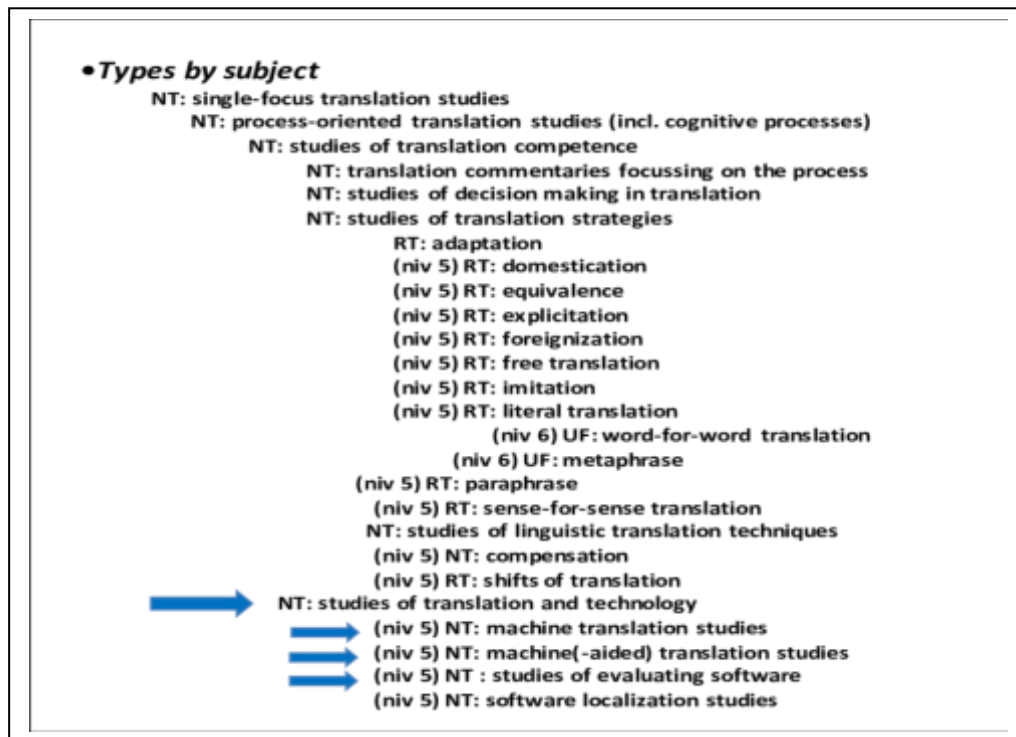
**Figure 3 Translation Tools:** This includes Translation Memory and Terminology Management software.

**2) Localization Tools:** This category encompasses Document Management and Translation Project Management.

**3) Linguistic Tools:** This subcategory further branches into two categories: Language-Connected (related to language) and Language-Independent. The Language-Connected tools include dictionaries and thesauri, while the Language-Independent tools include Optical Character Recognition (OCR) and concordancers.

On the other hand, Vandepitte’s ontological diagram (Vandepitte, 2008, p. 571), which classifies different types of topics in the field of Translation, represents the latest development

Figure 3 : Vandepitte ontological diagram



**Source: Vandepitte, S. (2008). “Remapping Translation Studies: Towards a Translation Studies Ontology”. Pp. 584-585**

The above diagram is a part of an extensive classification list prepared by Sonia Vandepitte (2008) to categorize and study translation studies based on three main approaches: purpose, method, and subject. Regarding the subject classification, it is evident that the field of translation and translation technology belongs to applied translation studies. This category includes studies related to machine translation, computer-assisted translation (CAT), as well as research evaluating translation programs and localization, investigating the translation process and the quality of its performance. Consequently, it encompasses various translation aids.

As for the content of these translation aids, Alcina (2008, pp. 79-102) has summarized some literature that presented different approaches and classifications of computer applications related to translation, each of which responds to various criteria or approaches. Among the most classical approaches is the division of translation programs into two main subcategories: Machine Translation (MT) and Computer-Assisted Translation (CAT). However, continuous growth in the field has led to the expansion and subdivision of these two categories into more

significant sub-sections, incorporating perspectives that have been considered fundamental for dividing the field. According to Alcina, these sub-sections include:

**According to the degree of automation in the translation process:** This approach relies on classifications presented by Hutchins & Somers (1992) and Hutchins & Somers developed a classification to measure the level of automation in the translation process when using computers, as illustrated in the following diagram:

**According to the stage at which tools are used in the translation process:** This approach categorizes the use of tools in the translation process based on different stages, such as pre-translation, translation proper, and post-translation tasks.

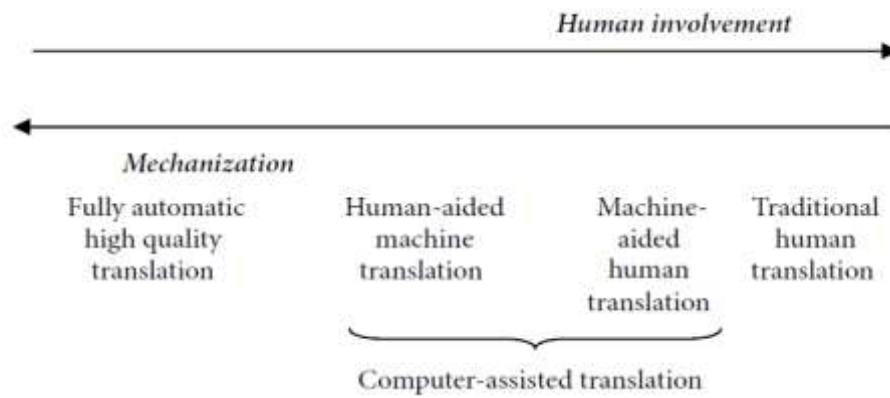
**According to the level of computer knowledge required:** This classification is based on the level of computer literacy and proficiency needed to operate translation technology effectively. It ranges from basic computer skills to advanced technical knowledge and programming capabilities.

**According to the relationship between technology and translation:** This approach examines how translation technology is integrated into the translation process, including machine translation systems, translation memory tools, and computer-assisted translation platforms.

**According to the translation dimensions in which computers are used:** This categorization focuses on the specific aspects of translation where computers and technology play a significant role, such as terminology management, corpus analysis, and quality assurance.

In the following subsections, we will elaborate on these various approaches and classifications in detail.

#### **Figure 4 : Human involvement and mechanisation**



**Source: Alcina (2008), *Translation technologies: Scope, tools and resources*, p. 81**

The term "Traditional human translation" refers to translation without any form of automation and has been practiced for centuries. On the other end of the spectrum, we find "Fully Automatic High-Quality Translation" (FAHQT), which refers to translation performed entirely by the computer without any human intervention. The attribute "high quality" was once considered an ideal and unattainable goal. "Human-Aided Machine Translation" (HAMT) denotes systems where the translation is primarily executed by the program itself but requires human assistance to address specific linguistic issues arising from the source text or to correct the translated output. "Machine-Aided Human Translation" (MAHT) encompasses any level of automation in the translation process, as long as it provides some form of linguistic support. This includes tools such as spell checkers, grammar rules, style guides, dictionaries, thesauri, encyclopedias, and other information sources that translators can refer to, either online or through other computer-assisted support. It also involves systems that utilize these tools to create a working environment that allows translators to work with both the source and target text, store and retrieve translations, known as the "translator's workstation."

On the other hand, Melby's classification belongs to the same approach but distinguishes between Level 1 and Level 2 tools (Melby, 1983, 1996):

**1- Level one:** This represents the tools that translators can use when the source text is provided on paper or via fax. These tools include speech-to-text conversion systems, word processors, fax machines, email, and other communication tools, word counting, and terminology management software. With the help of these tools, translators can virtually eliminate the distance between them and their clients, enabling them to compete with local

translators. Additionally, it allows for faster and more accurate invoicing and ensures greater consistency in the use of specialized terminology.

**2- Level two:** These tools require the source text to be in a machine-readable format. They include terminology research, automatic equivalence searching, translation memories, and quality assurance tools. All search operations, except for automatic searching, require a bilingual text set with alignment.

The classifications proposed by Hutchins and Somers (1992) and Melby (1983, 1996) have helped organize the relationships between technology and language processing, specifically between technology and translation. The first classification focuses on the use of technologies, while the second addresses their role in translation by creating different levels that facilitate the work of human translators. This results in a two-level classification of tools: the first based on the degree of human involvement (fully automatic translation, traditional human translation, and human-aided machine translation), and the second based on the extent of these tools' involvement in translation (required infrastructure level, terminology level, and segment level). However, the recent advancements in information technology, language processing, and translation necessitate the renewal and expansion of these classifications.

According to the stage at which the tools are used in the translation process, Melby (1998) proposes a classification of systems that can assist translators. This classification is based on the stage at which the translation process is applied (before, during, or after translation) and the level at which the tools operate (terminology level or segment level). These factors allow for the distinction of eight types of translation technologies (Melby, 1998) as follows:

**Infrastructure level:** These tools, although not specifically designed for translation, are essential in the translation environment. They include document creation and management systems, terminology databases, wired and wireless communications (Internet, email, file transfer protocol, web browsers, etc.).

**Term-level before translation:** These tools allow for the identification of terms qualified for inclusion in the terminology database, not limited to single words but also identifying terminological phrases. Terminology research covers online searches and searches within textual databases.

**Term-level during translation:** These tools automatically search for terms in the database and display their equivalents in the target language defined by the translator. The translator does not need to manually search for terms in the database as they can be integrated into the target text automatically.

**Term-level after translation:** These tools verify the consistent use of terms after completing the translation and identify terms the translator may wish to avoid using.

**Segment-level before translation:** These tools allow for the alignment of segments in the source text with corresponding segments in the target text and index them.

**Segment-level during translation:** This type includes tools for searching segments in the translation memory and machine translation.

**Segment-level after translation:** These tools detect missing segments (e.g., if a part of the text remains untranslated), verify compliance with rules, and preserve the formatting of the original text.

**Translation workflow & billing management:** While not directly involved in the translation process itself, these tools are crucial for tracking completed work, especially in large projects. They help control variables that can affect the processing of different texts in the project, such as deadlines, text revisions, translation priorities, review dates, and more.

INFRASTRUCTURE		
	TERM-LEVEL	SEGMENT-LEVEL
BEFORE TRANSLATION	- Term candidate extraction - Terminology research	- New text segmentation, previous source-target text alignment, and indexing
DURING TRANSLATION	- Automatic terminology lookup	- Translation memory lookup - Machine translation
AFTER TRANSLATION	- Terminology consistency check and non-allowed terminology check	- Missing segment detection and format and grammar checks.

TRANSLATION WORKFLOW AND BILLING MANAGEMENT

Figure 5 Classification of Translation Tools according to Melby (1998).

Source: Alcina (2008), *ibid*, p. 83

According to the level of computer knowledge required:

The focus on teaching translation and interpreting students to use technology has led to the development of various proposals for organizing the subject. One of these proposals is the "Language Engineering for Translators Curricula" (LETRAC) project. Its objective was to identify the technological elements that should be included in European university programs to train translators, facilitating their entry into the job market and ensuring compatibility between different European universities' translation studies. This initiative aimed to enhance students' mobility and equal opportunities. The project's starting point was to study how language engineering impacts the translators' working environment.

The knowledge structure related to translation technology is divided into three main groups:

- computer science,
- Information technology (IT) and desktop publishing (DTP) for translators,
- Language engineering.

Each unit within these groups contains different topics, providing information about the prerequisite knowledge requirements and determining which units are essential for training translators and which will be part of their specialized training.

The proposed curriculum for training translators under the LETRAC project includes numerous tools. However, some topics included in the curriculum, such as knowledge of programming languages or various operating systems, may not be particularly useful for professional translators today. On the other hand, there is significant importance given to the theoretical linguistic approach to machine translation (linguistic formulation theories, the history of machine translation, and systems). However, from a professional translator's perspective, the focus should be on practical aspects of machine translation, such as pre-editing and post-editing of texts, more than anything else.

According to the relationship between technology and translation, Vilarnau (2001) proposes a classification of computer programs into five categories based on their relevance to translation. These categories are as follows:

**Translation Programs:** This category includes various software tools used in the translation process, such as text processors, computer-aided translation (CAT) tools, machine translation (MT) tools, desktop publishing (DTP) applications, HTML editors, software localization tools, and others.

**Translation-Aid Software:** This group comprises databases, dictionaries, encyclopedias available on optical disks, web browsers, spreadsheets, spelling and grammar checkers, and other similar tools. These software programs assist translators in finding the correct terminology, accessing translation memories, and utilizing helpful reference materials during their work.

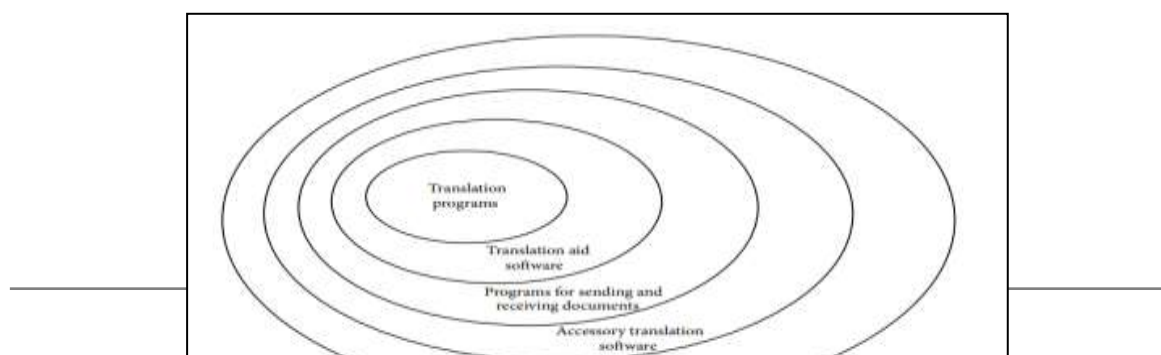
**Programs for Sending and Receiving Documents:** This category involves applications like email, File Transfer Protocol (FTP), optical character recognition (OCR) software, speech recognition tools, and so on. These tools facilitate the exchange of documents and communication between translators and clients.

**Accessory Translation Software:** This group includes utilities like compressors, encoding programs, chat applications, web networks, download management tools, and others. Although not directly related to the translation process, these programs contribute to creating a more efficient working environment and supporting translators in their tasks.

**General Programs:** This category consists of general-purpose applications such as antivirus software, operating system maintenance programs, and other similar tools. Although not exclusively designed for translation purposes, these programs play a crucial role in ensuring the security and smooth functioning of translators' devices and systems.

Vilarnau's classification effectively represents the relationship between computer programs and translation through five distinct circles, each encompassing the mentioned categories, as illustrated in the diagram below.

**Figure 6: Vilarnau's (2001) Classification of Computer Programs According to Their Relationship with Translation.**



**Source:** Alcina (2008, p. 87).

It is evident that the inner circles are closely related to translation compared to the circles further away from the center. As the circles move away from the center, they become more general, encompassing various fields beyond translation. The closer the circle is to the center, the more specific and relevant it is to translation.

This classification by Vilarnau (2001) is one of the early attempts focusing on professional translation and the needs of translators. It emphasizes that any tool usable by professional translators should be included within this framework and, accordingly, Vilarnau developed the classification into five distinct categories. However, the proposal does not provide any specific definition or explanation of the criteria used to select the included tools or to determine the degree of a particular program's relevance to translation.

According to Neunzig (2001, pp. 168-194), the application of computer tools in translation involves three dimensions: Translation Teaching, Professional Translation, and Translation Research. This classification adopts a process-oriented perspective, focusing on the nature of computer programs and resources used, as well as the user profiles, regardless of the specific technology they rely on.

While Neunzig's classification provides a good starting point to examine the various areas where translation technology is applied, it may not be suitable for classifying the tools themselves. The same tool can be useful for different purposes, such as research, teaching, and professional translation. The distinction lies in the specific usage, functions, and methods employed by each user profile. For example, a researcher may use a text analysis program like "WordSmith" to compare the frequency of a term in different sets of data, while a translator may use it to find contextual examples for term clarification, and a teacher may use it to create exercises for students. Therefore, it is necessary to differentiate between these three

dimensions, especially when designing courses for each user profile. However, such differentiation may not be very useful in classifying the content of the field or the tools themselves, as the same programs can be found in multiple categories.

After analyzing various classifications and the way translation technology is structured and categorized by different researchers and scholars for different purposes, we can conclude that early approaches relied more on the role of human translation in the overall translation process and the extent of human translators' use of technology-assisted tools. In contrast, modern approaches tend to rely more on machine translation and gradually reduce human intervention to save time, effort, and increase productivity.

### **3.Modern Trends**

#### **3.1.Neural Machine Translation**

Neural Machine Translation (NMT) is an algorithm based on neural networks that mimic the human brain. It learns to analyze words in the general context of a sentence while comparing the similarity of individual words and phrases. As a result, it produces more accurate automatic translations than ever before. Remarkable results have been achieved by various well-known companies, including Google, Systran, and Microsoft, which have started leveraging neural machine translation. This has also enabled them to add more language pairs and continuously feed their databases to maintain competitiveness in the global translation market. Consequently, these companies shifted their approach from statistical methods to neural models starting from 2016 (Borkovec, 2017).

Neural Machine Translation (NMT) attempts to simulate the learning structure of the human brain, using digital neural cells organized similarly to the neurons in the human brain. Researchers compare artificial neural networks to the brain of a young child who learns new information every day and gradually acquires knowledge, storing and retrieving it as needed. The artificial neural network is composed of processing units consisting of computational elements called "neurons," which store and process information in a comprehensive and connected manner. It includes a mathematical function that incorporates a set of input information, a set of variable resistors, one processing element, and a single output. This

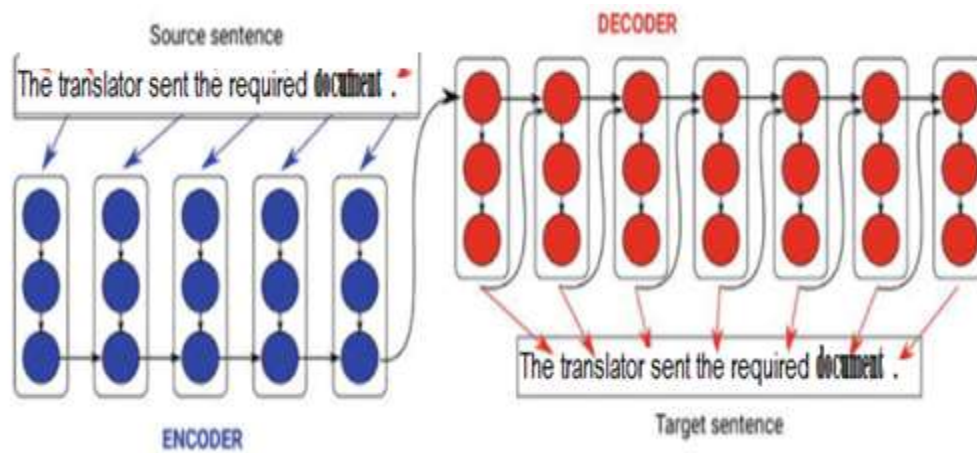
structure resembles the dendritic extensions in human nerve cells, and its most important characteristic is its adaptability to the changing environment.

NMT can generate translations that appear very natural, especially in highly general domains and with major European languages. However, it exhibits similar weaknesses to Statistical Machine Translation (SMT) in specialized fields and uncommon phrase transformations (2019 Farrall).

**Function of NMT:** The fundamental idea of Neural Machine Translation (NMT) lies in encoding a sequence of variable-length words into a fixed-length vector that can represent the entire sentence. The neural cell network, known as the "Encoder-Decoder Model" (Kyunghyun, 2014, p. 1), converts this encoded vector into another vector that needs to be decoded in the target language to obtain the complete translation of the source sentence. This is achieved by constructing and training a single large neural network that takes the entire input sentence and translates it into the target language in one go (Brouer & Benabbou, 2019). Hence, the NMT system consists of two essential neural networks: one that processes the input text sentences, and the other that generates the translated sentences using these vectors (Bahdanau et al. 2015, p. 1). That's why the Neural Machine Translation system is referred to as an "End-to-End Approach."

The encoding part of the system transforms the input text sentence into a sequence of words and then into a set of representations, which are iteratively formed from individual words. The decoding process provides the probability that a word is a continuation of what has been produced previously. This process is similar to the technique used to predict words in the keyboards of smartphones. The following illustration may give an idea of the Encoder-Decoder Model in Neural Machine Translation:

Figure number 7: An example of the Encoder-Decoder Model in Neural Machine Translation.



**Source: Adapted from Maučec and Donaj (2019). Machine Translation and the evaluation of its quality**

The proposal of "Bahdanau" (Bahdanau et al., 2014) for the Encoder-Decoder model with the "attention" mechanism has become the practical standard in Neural Machine Translation. The model relies on recurrent neural network layers that encode a specific sentence in the source language into a distributed representation. This representation is then decoded into the target language using another recurrent network.

To achieve the goal of translating the entire source sentence comprehensively, several models have been utilized.

### 3.2. Models of neural network models

**1. Recurrent Neural Network (RNN):** This model is designed to process sequences of data, making it suitable for sequential tasks like language translation. However, traditional RNNs have limitations in capturing long-range dependencies in a sentence.

**2. Feed-forward Neural Network (FNN):** Unlike RNNs, FNNs do not have recurrent connections, and each layer processes the input independently. They are often used for feature extraction and can be combined with other models in more complex architectures.

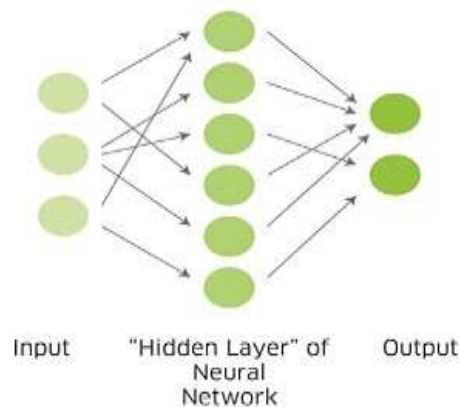
**3. Transformer:** The Transformer architecture, introduced by Vaswani et al. (2017), revolutionized Neural Machine Translation with its attention mechanism. It efficiently captures dependencies between words in a sentence and allows for parallel processing, making it faster than traditional RNN-based models.

### 3.3. Recurrent Neural Network (RNN):

Recurrent Neural Networks (RNNs) are models designed to process sequential data, and due to their internal memory, they were among the early algorithms capable of retaining such inputs (Morchid, 2017). They are a remarkable achievement of Deep Learning in recent years. RNNs are considered one of the most powerful and efficient types of neural networks because they have internal memory. In these Recurrent Neural Networks (RNNs), information flows in a loop, where when a decision is made, it takes into account both the current inputs and what it has learned from previous inputs.

What distinguishes an artificial neural network from the human brain is that it does not forget what it has acquired. Every piece of information received by the artificial neural network is stored and retained indefinitely (Mikolov et al, 2015, p. 2). Simulating the human mind in designing Neural Machine Translation systems helps algorithms learn from mistakes and repetitions, and how to remember and make sound decisions. It enables the storage of information in an organized form and retrieval when needed. If the user modifies the linguistic data or corrects an error, the program quickly and automatically adapts to this change

**Figure 8: Examples of Feedforward Artificial Neural Network Architectures.**



**Source: Koehn, Neural Machine Translation, Ch.13, (2017), p. 8**

### **3.4.Feed Forward Neural Network**

Feed Forward Neural Networks (FNN) are named based on how they process information. Information flows in only one direction: from the input layer to the output layer, passing through hidden layers, where each neuron is connected to the neurons that precede and follow it in other layers. Therefore, the information does not touch the same node twice (Brou

& Benabbou, 2019). FNNs have different types, with one of the most important being Convolutional Neural Network (CNN).

**3.5.A Convolutional Neural Network (CNN)** is a special type of feed-forward neural network inspired by biological processes occurring in the visual cortex of living organisms. It is considered a solution to many computer vision and artificial intelligence problems CNNs are used in image recognition and processing, performing tasks such as classification, description, recommendation systems, and natural language processing.

Traditional neural networks are not ideal for image processing due to their low accuracy. However, CNNs have specialized neural cells present in the visual cortex, which is responsible for processing visual stimuli in humans and animals. The arrangement of neural cell layers covers the entire visual field, avoiding the problem of partial image processing in traditional neural networks. CNN layers consist of an input layer, output layer, and hidden layers, including multiple convolutional layers, pooling layers, fully connected layers, and normalization layers. This results in increased efficiency in image and natural language processing, achieving a more effective and straightforward system.

Convolutional Neural Networks are powerful models for deep learning and are applied in a wide range of fields such as translation. Their usage increases with the growth of data volume to handle more complex and challenging tasks (Brouer & Benabbou, 2019).

Indeed, Feed Forward Neural Networks (FNN) lack memory of past inputs, making them less effective in prediction for future inputs. These networks only consider the current input without any notion of the appropriate temporal order, thus unable to remember what happened before (except for training data). However, this limitation has been addressed by using the backpropagation technique.

Backpropagation is a key technique used in training neural networks, including feed-forward networks. It allows the network to learn from its mistakes and adjust its weights and biases based on the errors made during the training process. By propagating the error backward through the network, the model can update its parameters to minimize the difference between the predicted output and the actual output for a given input. This iterative

process of adjusting the network's weights and biases allows it to learn patterns and relationships within the data and improve its performance, including the ability to make predictions for future inputs.

So, while Feed Forward Neural Networks lack memory and the ability to consider the temporal order of inputs, the use of back-propagation during training helps overcome this limitation and enables them to learn and improve their predictions.

#### **4.Back Propagation**

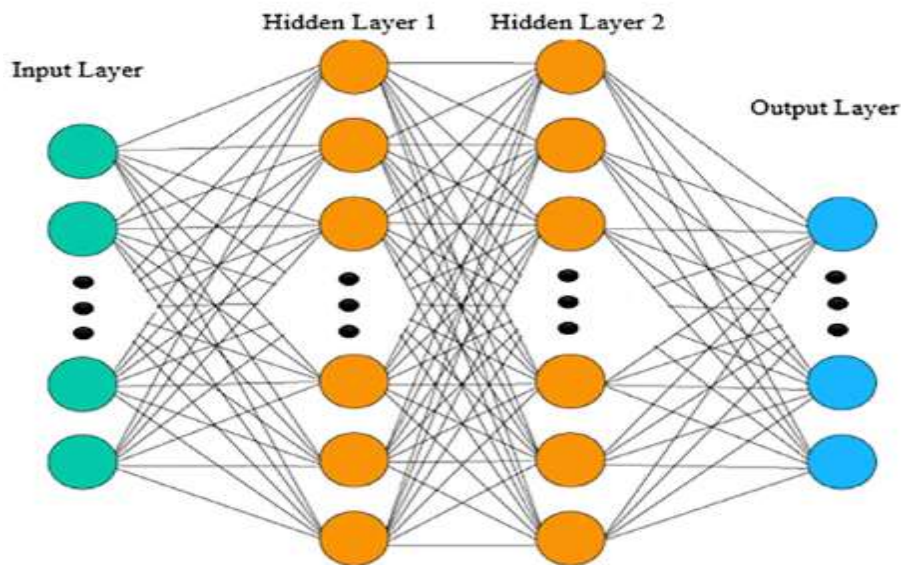
In neural networks, the process of forward propagation is executed to obtain the output result that needs to be checked for its correctness. Subsequently, back-propagation is applied, which involves traversing the network from the last layer to the first layer to search for the partial derivatives of the error while respecting the weights. This allows the computation of how much this value affects the weights, making it possible to subtract this value from the weights.

Then, these derivatives are used through a suitable gradient descent algorithm, which is an optimization algorithm used to minimize a specific function iteratively. The weights are adjusted up or down based on what reduces the error. In this way, the neural network learns from the neurons during the training process (see the following figure). Therefore, back-propagation is the process of adjusting the model's weights during the training phase (Brouer & Benabbou, 2019).

Back-propagation is a fundamental part of training neural networks. By calculating the gradients of the error with respect to the model's parameters, it allows the model to update its weights and biases so that the predictions get closer to the target values during training. This iterative process helps the network learn and improve its performance over time, enabling it to make better predictions and generalize to new data. The use of back-propagation has been instrumental in making neural networks more effective and powerful for various tasks, including machine translation.

The following figure illustrates a model that highlights the functioning of a Feed Forward Neural Network with both forward and backward propagation, along with two hidden layers, input layer, and output layer.

**Figure 9: Model of a Feedforward Neural Network with Backpropagation.**



**Source: Brour & Benabbou, Arabic text language into Arabic sign language neural machine translation, (2019).**

While Neural Machine Translation appears to produce more fluent translations compared to its Statistical Machine Translation counterparts, the latter (SMT) still maintains the advantage of accuracy. Additionally, post-editing in Neural Machine Translation is generally easier. It is worth mentioning that translators should be cautious about translations that appear smooth and fluent as they may hide significant errors. Regardless of the apparent accuracy of the final output from automated translation, the editor will still need a human translator to carefully compare it with the original text (Farrall, 2019).

## **5.Results and Discussion**

The results of this study present a comprehensive classification of translation tools used in professional translation practice. To achieve this objective, we examined the classifications proposed by Melby (1998), Vilarnau (2001), and Neunzig (2001), each offering a unique perspective on translation technology.

The classification of translation tools presented in this study offers a robust framework for understanding translation technology and its implications for professional practice. Identifying the various tool categories has helped to better understand their specific applications in the translation process. By highlighting the

close connections between certain tools and translation, we underscored their potential to enhance translators' efficiency and accuracy.

Importantly, the study's results also indicate the evolving role of technology in translation. While earlier approaches emphasized integrating translation tools with human translators' work, current trends increasingly prioritize machine translation to optimize time and productivity.

In conclusion, this research provides a comprehensive perspective on available translation tools and their respective applications. By analyzing the various dimensions and classifications of translation technology, the study contributes to the development of customized training programs for translators, ensuring they are equipped with the most appropriate tools to meet the ever-changing demands of the translation market.

## 6. Conclusion

The results of this study emphasize the importance of understanding the various stages at which translation tools are applied in the translation process. Melby's classification highlighted the significance of differentiating tools based on their association with pre-translation, during translation, or post-translation stages, as well as their relation to terminological or segmental levels. This understanding allows for a more informed selection of appropriate technologies to meet the specific needs of professional translators.

Vilarnau's classification revealed that the relevance of translation tools varies based on their degree of association with translation tasks. Translation programs and translation-aid software were found to be highly relevant and beneficial for professional translators, while general programs offered fewer specialized features.

The incorporation of Neunzig's three-dimensional approach emphasized the importance of tailoring translation tools to the specific requirements of different user profiles: teachers, professional translators, or translation researchers. This understanding acknowledges that each user group can benefit uniquely from translation tools suited to their particular tasks and objectives.

The significance of this research lies in its practical implications for the translation industry. By providing a clear classification of translation tools and their applications, this study offers valuable guidance for translation practitioners, educators, and researchers. It facilitates the development of tailored training programs that equip translators with the most suitable tools to enhance their efficiency and accuracy in meeting the demands of the fast-paced translation market.

Moreover, this research contributes to the ongoing discussion on the role of technology in translation. The study revealed that while early approaches emphasized the integration of human translators with technology-assisted tools, modern trends prioritize machine translation to optimize time and productivity. This shift reflects the evolving landscape of translation practice and offers valuable insights into the potential impact of technology on the profession.

In conclusion, the comprehensive classification of translation technology presented in this research serves as a valuable resource for the translation industry. By understanding the different types of tools available and their specific applications, translators can enhance their performance, offer high-quality translation services, and keep pace with the ever-evolving technological advancements in the field. As the demand for efficient and accurate translation services.

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