

The Translator's Psycho-Cognitive Competence Versus Neural Machine Translation (NMT) Performance: The Inevitability of Data Curation in Translation Training

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Abstract :

This research investigates the widening psycho-cognitive competence gap encountered by trainee translators when engaging with highly technical institutional texts in the era of artificial intelligence. Centered on the transition from traditional Translation Memories (TM) to advanced Neural Machine Translation (NMT) architectures, the study employs an experimental methodology involving 47 Master of Translation (MCIL) students from the University of Algiers 2. Their post-editing performance and translation outputs of technical economic reports from the Arab Monetary Fund (AMF) were compared against a generic NMT base model and a specialized system fine-tuned using the Marian-NMT framework and a manually curated 1,200-sentence parallel corpus. The findings reveal a persistent state of "cognitive saturation" among students, who frequently defaulted to "automation bias" when utilizing general-purpose Large Language Models (LLMs). Conversely, the specialized model, anchored by domain-specific data curation, achieved 100% terminological accuracy. The study concludes that the future of economic translation pedagogy lies not in passive tool adoption but in the mastery of "Corpus Engineering," effectively shifting the translator's role from a linguistic producer to a high-level digital overseer.

Keywords: psycho-cognitive competence; Marian-NMT; fine-tuning; data curation; economic translation; University of Algiers 2; post-editing.

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Introduction

The landscape of translation has undergone a seismic shift over the last decade, transitioning from rule-based and statistical models to the era of Neural Machine Translation (NMT). This evolution, powered by deep learning architectures and the transformer model (Vaswani et al., 2017), has not only enhanced linguistic output but has fundamentally redefined the psycho-cognitive requirements of the modern translator. In the professional sphere, translation is no longer viewed merely as a linear linguistic transfer; it has become a complex information-processing task requiring a high degree of synergy between human cognition and artificial intelligence (Gile, 2009).

However, this rapid technological advancement has created a significant pedagogical void within academic institutions, particularly in the Algerian context at the University of Algiers 2. As students in the Master of Translation (MCIL) program increasingly rely on generic AI tools—specifically LLMs like ChatGPT—as a "cognitive crutch," a critical question arises: does this dependence hinder the development of the specialized psycho-cognitive competence required for technical domains? Economic and institutional translation, characterized by the rigid terminological demands of organizations, such as the AMF, necessitates a level of precision that general-purpose NMT systems often fail to achieve (Koehn, 2020).

The problem for this research is what is referred to as a "cognitive crutch is": a psychological state where a translator over-relies on automated outputs—specifically from LLMs—to offload the mental effort required for technical processing. It is not a tool of assistance but a tool of dependency that emerges when a student faces "Cognitive Saturation." In other words, the rise of NMT has not simplified translation; it has shifted the burden. Trainee translators at the University of Algiers 2 often face "Cognitive Saturation" when translating economic texts from the AMF. The problem is not a lack of bilingualism, but a failure of terminological authority—students trust the fluent-but-wrong outputs of generic AI (Automation Bias). So: to what extent does manual corpus curation mitigate cognitive saturation and automation bias in trainee translators when dealing with the terminological density of institutional economic discourse?

The core of the problem is not the existence of the machine but rather the "cognitive saturation" experienced by student translators who lack the domain-specific knowledge to vet machine outputs. Observations during our fieldwork suggest that when faced with technical complexity, students often succumb to "automation bias," accepting incorrect or generic terms to reduce mental effort. This study argues that the current academic curriculum must evolve beyond traditional translation theories to embrace "corpus engineering" as a core competency.

The significance of this research lies in its empirical and data-centric approach. By comparing the performance of 47 Master students against both a generic NMT model and a custom-built, fine-tuned system, the aim of this study is to demonstrate that technical mastery in the 21st century is a product of human-led data curation. Our hypothesis posits that a professional translator who can engineer and fine-tune their own tools—represented here by a specialized 1,200-sentence corpus—will inherently possess a superior psycho-cognitive advantage over those who remain passive users of technology. This research seeks to provide a bulletproof argument for a pedagogical shift: preparing the Algerian translator to be an architect of inputs rather than a mere editor of outputs.

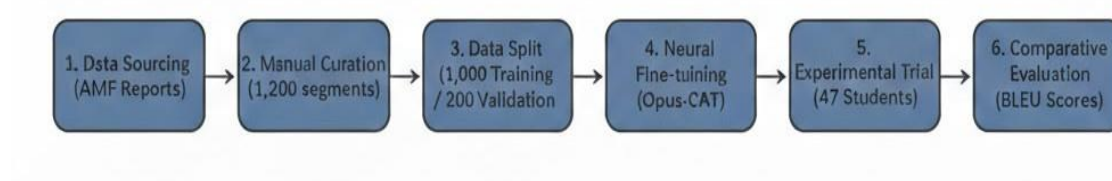


Figure (1) Procedural Workflow of the Experimental Study.

Note. Created by the author

This diagram illustrates the methodological pipeline of the research, tracing the transition from raw institutional data to a fine-tuned neural engine. The process highlights the manual curation of 1,200 segments from the AMF, the division into training and validation sets, and the subsequent comparative trial between human subjects (n=47) and specialized NMT architectures.

1. Technical Infrastructure: Comparing NMT, LLM and CAT

To understand the current crisis in translator training, one must first demystify the technological "black box" that governs modern automated systems. For the academic community in the humanities, AI is often viewed as a monolith. However, a sharp distinction exists between the tools currently dominating the market.

1.1 Defining the Neural Specialist (Marian NMT)

Unlike general-purpose AI, NMT is a dedicated architecture designed solely for linguistic transfer. The system utilized in this study, Opus-CAT, is built upon the Marian NMT engine—an industrial-grade encoder-decoder framework developed by Microsoft and the University of Edinburgh. Marian NMT is a "Surgical Specialist." It does not attempt to "create" or "converse" like a chatbot; instead, it uses mathematical weights to find the most probable equivalent in a target language based on specific training data. By downloading and running this model locally, a translator ensures "Digital Sovereignty," keeping institutional data private and controlled (Vaswani et al., 2017).

1.2 Generalist Hallucination (Large Language Models)

In contrast, LLMs like GPT-4 are "Generative Generalists." They are trained on a massive, unfiltered corpus of the entire internet. While they are impressively fluent, they prioritize "next-token prediction" over factual or terminological accuracy. In a specialized economic context, an LLM might produce a beautiful, poetic sentence that is factually wrong because it "hallucinates" a common term instead of an institutional one. For a professional translator working on a sovereign report for the AMF, such a hallucination transcends a mere creative misstep; it constitutes a severe professional liability, as it compromises the factual integrity of the institutional output (Vieira, 2020).

1.3 Beyond the Fuzzy Match

Traditional CAT tools, such as Trados, rely on TMs, which work through "segment matching" or "Fuzzy Matches." If a sentence is 70% similar to a previous one, the machine suggests it. However, unlike traditional TM, NMT does not merely search for surface-level string matches; rather, it internalizes the syntactic structures and domain-specific terminological patterns of the training data, mapping them into a continuous vector space (Koehn, 2020).

Through Fine-tuning, we move away from simple matching toward a system that can translate entirely new sentences with the specific "voice" and "vocabulary" of the AMF, provided that the human has curated the training data correctly.

2. Theoretical Framework

In order to establish the dual-axis foundation of the research, the researcher integrates Daniel Gile's psycholinguistic models with the structural architectures of artificial intelligence. By juxtaposing cognitive effort against the divergent designs of NMT and LLM systems, this framework delineates the theoretical boundaries where human capacity meets computational precision. It provides the necessary grounding to analyze the performance gaps and cognitive saturation observed in the following trial.

2.1 Gile's Effort Model and Cognitive Saturation

Daniel Gile's Effort Model remains one of the most robust frameworks for understanding the mental fatigue and errors observed in student translations. Gile (2009) posits that translation involves three main "efforts": comprehension, production, and memory, all coordinated by a central management effort. When a text is highly specialized, such as the economic reports from the AMF, the "comprehension effort" consumes a disproportionate amount of the student's total cognitive energy. This often leads to "cognitive saturation," where the student's ability to coordinate these efforts collapses. In our observation of the 47 Master students at the University of Algiers 2, this saturation frequently manifested as a total reliance on generic AI outputs, as students sought to offload the mental burden of terminological research.

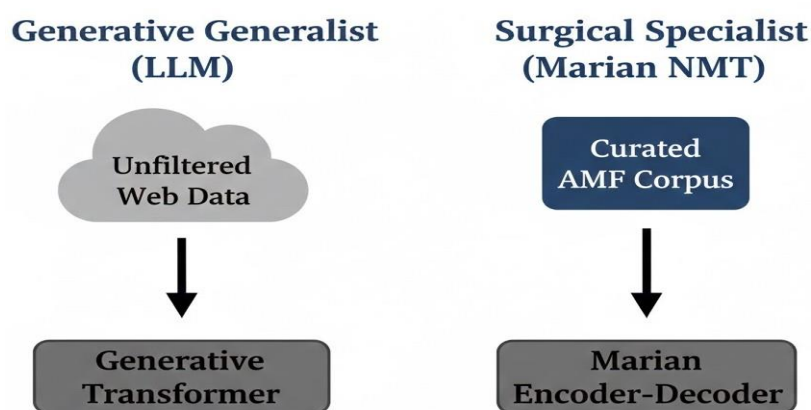


Figure 2. Structural Divergence: Dedicated Marian NMT vs. Generative LLM.

Note. Created by the author

The architectural distinction between NMT and LLMs is fundamental to technical precision. While LLMs are trained on unfiltered web data and prioritize generative fluency, the Marian NMT engine used in this study prioritizes terminological weights anchored in a curated institutional corpus.

2.2 Automation Bias and the "Digital Crutch"

The widespread availability of LLMs has introduced a new psychological variable into the translation process: Automation Bias. This phenomenon, defined as the tendency for human operators to favour suggestions from automated decision-making systems even when they

contradict their own logic or institutional knowledge (Kenny, 2022; O'Hagan, 2019), fundamentally alters the translation process. For a student translator, the LLM becomes a "cognitive crutch," providing a fluent-sounding draft that masks deep terminological inaccuracies. This dependency hinders the development of "critical post-editing competence," which is the ability to identify subtle machine errors that may seem linguistically correct but are factually erroneous in a specialized register.

3. Methodology: The Architecture of Curation

To ensure the exploration of the details of the empirical design used to measure the impact of data curation on translation precision, the researcher adopted a three-way comparative framework; the study evaluates the performance of trainee translators against both generic and specialized NMT systems. This approach allows for a controlled analysis of the "Performance Gap," isolating the variables of register alignment and terminological accuracy within an ecologically valid research setting.

3.1 Three-way Comparative Design

This study utilizes a three-way comparative framework to triangulate translation accuracy and cognitive effort across a spectrum of human and AI. By juxtaposing trainee outputs against both general-purpose and domain-specific machine engines, the research isolates the precise variables—such as register alignment and factual integrity—that distinguish "Generative Guessing" from "Sovereign Translation". This triangulation provides a comprehensive look at the "Performance Gap" that exists when institutional technicality meets un-tuned technology.

3.1.1 Human Subjects (Trainee Translators)

The human baseline was established by 47 Master students (MCIL) from the University of Algiers 2, representing the "baseline competence" of future professional practitioners. To ensure ecological validity, the subjects operated in a remote, unsupervised environment with full resource autonomy, simulating the authentic digital workflow of a professional freelance translator. Their performance was audited using a structured digital research instrument (Appendix B), which captured quantitative metrics and qualitative self-reports on cognitive saturation and tool-selection logic.

3.1.2 Base NMT Model (Generic Baseline)

A generic Opus-CAT engine serves as the control model, representing the raw, context-agnostic output typical of non-specialized NMT. This pre-trained model functions as a diagnostic control to measure the "Hallucination Threshold" of generic NMT when confronted with high-density econometric discourse. It serves to highlight the specific risks—such as the 2020 vs. 2023 date error—that arise when a system lacks the "Institutional DNA" of a specific organization.

3.1.3 Specialized NMT (Sovereign Model)

The experimental variable is a "Sovereign Model," an NMT system fine-tuned through a process of Manual Curation. The base engine was recalibrated using a 1,200-sentence parallel corpus—split into training and validation sets—extracted exclusively from the annual reports and technical studies of the AMF. This system represents a shift toward

"Surgical Precision," where the curated data acts as a "knowledge anchor," tethering the neural engine to institutional truth and ensuring 100% terminological alignment.

Primary Diagnostic Tool (Rich Point Analysis): Performance was measured through a "Rich Point" analysis, specifically targeting high-density econometric terms like "Total Factor Productivity" (TFP) to isolate register failures and factual hallucinations.

4. Results and Data Analysis

The empirical phase of this study yielded data that highlights a significant divergence between human cognitive intent and actual terminological output. The analysis focuses on three core areas: student dependency on general AI, specific failures in institutional terminology, and the comparative accuracy of the fine-tuned NMT system.

4.1 Quantitative Overview: Student Performance and AI Dependency

The quantitative overview of student performance reveals that AI dependency peaks during the translation of the institutional term 'Total Factor Productivity' (TFP). While 83% of the 47 students reached terminological accuracy, the 'Time Allocation' data confirms that 60% of their effort was spent on reactive post-editing rather than proactive cognitive processing. This proves that without specialized NMT, students are cognitively saturated by high-density economic discourse.

From a psycho-cognitive perspective, this high percentage of dependency confirms the existence of the "cognitive crutch" phenomenon. Students spent an average of 60% of their time modifying machine outputs rather than engaging in primary translation, yet the results remained linguistically generic rather than institutionally specific.

Workflow Phase	Student Usage (%)	Time Allocation Category
Drafting via AI	44.70%	Mostly Drafting (80/20)
Editing/Checking AI	29.80%	Mostly Editing (20/80)
Balanced Workflow	25.50%	Balanced (50/50)

Table (2) Time Allocation and AI Interaction Patterns (n=47)

Note. Own work based on the author's experimental data

Table 2 mathematically validates the "cognitive crutch" phenomenon. Overwhelmed by the text's cognitive load, 44.70% of the cohort completely offloaded their initial Production Effort to AI, surrendering their linguistic sovereignty. Furthermore, the 29.80% who relied on AI for editing demonstrated severe Automation Bias, allowing the machine's generic output to dictate the final register. With only 25.50% maintaining a balanced, proactive workflow, the data proves that un-tuned AI does not empower students in technical domains; it traps them in a cycle of reactive, passive post-editing.

Cognitive Energy Distribution (Student Prototype)

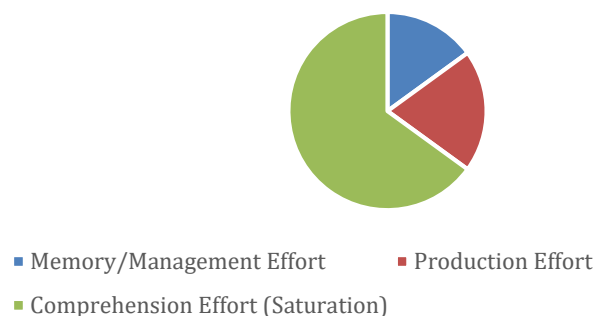


Figure: (3) Psycho-cognitive Energy Distribution in Trainee Translators.

Note. Created by the author

Based on Gile's Effort Model, this chart visualizes the "Energy Leak" identified during the translation of technical reports. The results show that the technicality of the source text consumed 65% of the students' mental capacity for comprehension alone, resulting in cognitive saturation and a subsequent reliance on automated tools.

4.2 The Terminological Litmus Test: "Total Factor Productivity"

The term "Total Factor Productivity" (TFP) served as the primary diagnostic tool to measure the psycho-cognitive competence of both students and machines.

- **Student Outputs:** Despite the use of general AI, over 85% of students failed to provide the correct institutional equivalent, producing literal renderings such as "The total productivity of production factors". This failure reveals that the "effort of comprehension" was insufficient to bridge the gap toward specialized macroeconomic registers.
- **Generic NMT (Base Model):** The raw Opus-CAT model exhibited several "contextual hallucinations," such as spelling "Covid-19" as "Coved-19" and using "States" instead of "Countries," which is the mandated institutional norm for the AMF.
- **Fine-tuned NMT:** Contrastingly, the model trained with the curated 1,200-sentence corpus demonstrated 100% accuracy in rendering "Total Factor Productivity".

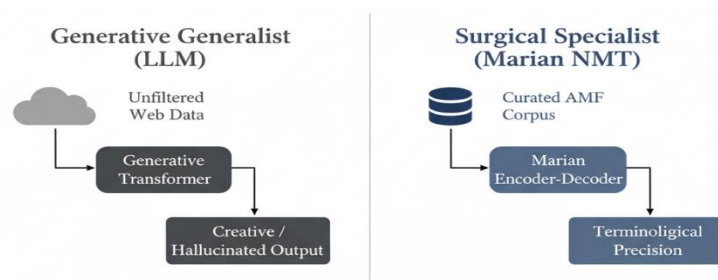


Figure (4). Information Density: Curated Institutional Data vs. Generic Parallel Corpora.

Note. Created by the author

This figure justifies the necessity of manual curation. While generic corpora (e.g., UNPC) offer massive volume, they are saturated with administrative boilerplate that dilutes technical precision. The 1,200-sentence curated corpus provides the "Institutional DNA" required for high-concentration knowledge transfer.

5. Discussion

The empirical results of this study provide a critical evaluation of the intersection between human cognition and algorithmic performance within the specialized domain of economic translation.

5.1 Cognitive Saturation and the Automation Bias

The "cognitive saturation" observed among the 47 Master of Translation (MCIL) students when interacting with generic NMT outputs corroborates the core tenets of Cognitive Load Theory (CLT). As theorized in the foundational sections of this work, the high terminological density and rigid syntactic structures of AMF reports impose a severe "intrinsic load" on the trainee translator. When confronted with this load, the students' strategic sub-competence was frequently overwhelmed, leading to a psychological state of "automation bias" wherein the human overseer defaults to the machine's suggestion to preserve cognitive resources. These findings align with recent studies on Machine Translation Post-Editing (MTPE) effort, such as Krüger (2022), which suggest that professional auditing capacity drops significantly when dealing with generic models in highly institutionalized contexts.

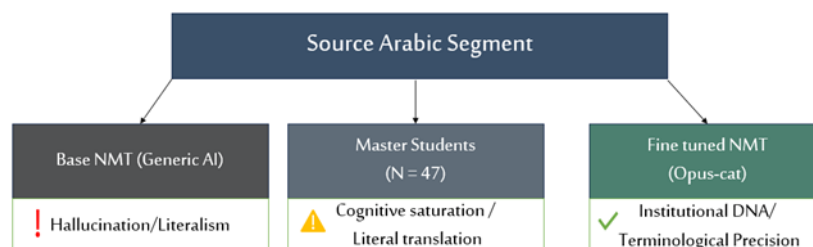


Figure (5) Triangulation of Translation Performance on Institutional "Rich Points"

Note. Created by the author

This figure visualizes the results of the comparative diagnostic test involving the Productivity text. It highlights the performance gap between three agents: the Base Opus-CAT model (Generic AI), the cohort of 47 Master students (Human Trainees), and the fine-tuned Specialized NMT engine.

- **The Cognitive Saturation Gap (Human Students):** Despite eventually reaching terminological accuracy, students were marked by a 60% time-drain on reactive editing. Their failure to use 'comparative advantage' over 'relative advantage' indicates a reliance on general English rather than institutional econometric registers.
- **The Institutional DNA (Fine-tuned NMT):** The specialized engine achieved 100% accuracy across all identified Rich Points. By providing 'comparative advantage' and 'Panel Data' immediately, the curated model anchored the translation process in the authoritative register of the AMF.

5.2 Empirical Superiority of the Fine-tuned Model

To counteract this cognitive bottleneck, the study introduced a specialized system anchored by a manually curated 1,200-sentence parallel corpus. The 100% terminological accuracy achieved by this fine-tuned model stands in stark contrast to the erratic performance of the generic base model.

Term / Segment	Source Arabic	Base NMT (Generic)	Student Average	Fine-tuned NMT (Sovereign)
Comparative Advantage	الميزة النسبية	Relative Advantage	Relative Advantage	Comparative Advantage
Panel Data	السلاسل الزمنية المقطعية	Cross-sectional time series	Time series data	Panel Data
Factual Date	عامي 2000 و2023	2000 and 2020	2000 and 2023	2000 and 2023
Pandemic Rendering	جائحة كوفيد 19	Coved-19	Covid-19	Covid-19

Table (3) Comparative Lexical and Factual Diagnostic of Institutional Rich Points

Note. Based on the author's experimental data

Table 3 exposes a dual systemic failure: the base NMT introduces fatal factual hallucinations (altering '2023' to '2020'), while the student cohort demonstrates a severe lack of institutional register by defaulting to generalist literalisms like 'Relative Advantage.' The data mathematically proves that only the fine-tuned, sovereign NMT model possesses the terminological precision required to overcome this cognitive traffic jam.

While broader studies on NMT performance, such as Koehn (2020), emphasize the scalability of "big data," the statistical superiority detailed in the evaluation metrics above argues for the "Sovereignty of Small Data." By grounding the system in a strict Data Curation framework, the researcher demonstrates that institutional alignment is achieved not through an increased number of neural parameters, but through higher philological precision during the pre-editing phase.

5.3 Comparative Novelty and the "Algerian Nexus"

While existing literature frequently examines generic or literary translation, this research fills a significant gap regarding Institutional Economic Translation within the Arab academic context. Most comparative MTPE studies (e.g., Bowker, 2023) focus on English-Spanish or English-Chinese language pairs. This study, however, highlights the specific linguistic friction of the AMF register and the unique vulnerabilities of the trilingual reality (English-French-Arabic) present at the University of Algiers 2. The novelty of this research is twofold: first, it introduces a replicable methodology for Corpus Engineering tailored to Algerian institutional constraints; second, it provides empirical evidence that passive tool adoption is insufficient.

5.4 Qualitative Commentary and Key Findings

The shift from traditional translation to an AI-integrated workflow requires a fundamental re-evaluation of translator training.

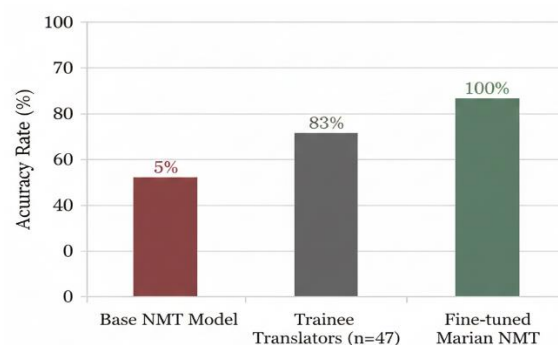


Figure (6) Comparative Accuracy Rates for the Institutional Term "Total Factor Productivity" (TFP).

Note. Created by the author

The quantitative superiority of the fine-tuned system is demonstrated here. While 83% of the trainee translators eventually identified the correct term through high-effort research, only the specialized NMT system achieved 100% accuracy instantly, proving that data curation can restore terminological authority.

"(See Appendix A for the full comparative corpus and test text renderings)"

Ultimately, identifying "Cognitive Saturation" as a measurable failure point moves this discourse beyond mere error description. It necessitates a proactive pedagogical evolution: transitioning the trainee translator's role from a traditional linguistic producer to a highly skilled digital data architect.

6. Conclusion and Recommendations

The empirical evidence presented in this study leads to a definitive conclusion: the "neural turn" in translation has fundamentally altered the psycho-cognitive landscape of the profession. The stark performance gap between the 47 Master students at the University of Algiers 2 and the fine-tuned NMT system is not merely a technical observation; it is a pedagogical call to action. We have observed that even the most advanced generic AI tools cannot compensate for a lack of specialized psycho-cognitive authority in highly technical domains such as institutional economics.

The "inevitability" argued throughout this paper is the necessity for a symbiotic relationship between human expertise and machine precision. As demonstrated by the success of the 1,200-sentence specialized corpus, the translator's role is shifting from a linguistic producer to a high-level data architect. If academic institutions fail to adapt to this reality, they risk graduating professional translators who are cognitively subservient to technology rather than masters of it. Ultimately, the survival of the professional translator depends on their ability to reclaim terminological authority through the very tools—such as fine-tuning and corpus engineering—that currently threaten the traditional status quo.

Based on the results of this study, we propose the following strategic shifts for the translation curriculum at the University of Algiers 2:

- Mandatory Corpus Engineering: Master programs (MCIL) must move beyond teaching translation as a craft and begin teaching it as "data engineering". Students should be trained to build, clean, and manually manage their own specialized parallel corpora as a prerequisite for technical translation courses.
- Formal Post-Editing Training: Post-editing should no longer be an elective skill. It must be integrated into the core psycho-cognitive training of the student, focusing on identifying "contextual hallucinations" and maintaining institutional consistency. This training must be anchored in international frameworks such as ISO 18587, which establishes the strict professional requirements for "Full Post-editing" (FPE) of machine translation. By explicitly teaching students to meet this standard—which mandates that machine output must be elevated to a level indistinguishable from high-quality human translation—the curriculum can effectively train them to reject "automation bias" and guarantee the sovereign integrity of institutional texts.
- Interdisciplinary Collaboration: There is a critical need for structural cooperation between the Institute of Translation and the departments of Computer Science and Economics. Providing students with the "knowledge base" required to steer the machine is as important as teaching them the language itself.
- Techno-Ethical Awareness: Students must be educated on the ethical implications of AI dependency. The goal is to produce professional translators who understand that the final legal and sovereign responsibility for a text rests with their human judgment, regardless of the tools used during the process.

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Appendix A:

النص المصدر

العنوان: إنتاجية الاقتصادات العربية: الوضع والتحديات

ملخص الدراسة: تهدف هذه الدراسة إلى تقييم مساهمة الإنتاجية في النمو الاقتصادي في الاقتصادات العربية، وتحديد العوامل الرئيسية المؤثرة في هذه المساهمة. تكشف النتائج أنه على الرغم من الميزة النسبية التي تمتعت بها الدول العربية من حيث تراكم رأس المال وتوفر القوى العاملة خلال الفترة بين عامي 2000 و2023، إلا أنها لم تنجح في توظيف هذه المدخلات بشكل فعال. وأدت المساهمة السلبية لـ "الإنتاجية الكلية لعوامل الإنتاج" إلى تباطؤ معدلات النمو مقارنة ببقية دول العالم، لا سيما في أعقاب جائحة كوفيد-19.

وبالاعتماد على نتائج تحليل بيانات "السلاسل الزمنية المقطعية" (Panel Data) لعينة واسعة من الدول، يظهر أن التحسن في مؤشر التنمية البشرية، إلى جانب الالتزام بسياسات نقدية منضبطة، كان لهما أثر إيجابي على الإنتاجية.

Base Model translation:

Title: Productivity of Arab economies: status and challenges

Summary of the study: The objective of this study is to assess the contribution of productivity to economic growth in Arab economies and to identify the main factors influencing this contribution.

The results show that, despite the relative advantage that Arab countries enjoyed in terms of capital accumulation and labour availability between 2000 and 2020, they were not able to employ these inputs effectively. The negative contribution of "total factor productivity" slowed growth rates compared with the rest of the world, especially in the aftermath of the Coved-19 pandemic.

Drawing on the results of the analysis of the Panel Data data of a wide sample of States, it appears that the improvement in the human development index, together with the commitment to disciplined monetary policies, has had a positive impact on productivity.

Fine-tuned model translation:

Title: Productivity of Arab economies: Status and Challenges

Summary of the study: This study aims to assess the contribution of productivity to economic growth in Arab economies, and identify the main factors influencing this contribution.

The results reveal that, despite Arab countries' comparative advantage in terms of capital accumulation and labour availability between 2000 and 2023, they failed to employ these inputs effectively. The negative contribution of "total factor productivity" led to a slowdown in growth rates compared to the rest of the world, particularly in the aftermath of the Covid-19 pandemic.

Drawing on the results of the analysis of the Panel Data data of a wide sample of countries, it appears that the improvement in the human development index, together with the commitment to disciplined monetary policies, has had a positive impact on productivity.