

The Expert Systems as an Artificial Intelligence Solution for E-Commerce: Outlining a Conceptual Framework

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The increasing integration of Artificial Intelligence (AI) and digital technologies in e-commerce requires intelligent solutions capable of supporting decision-making, improving customer experience, and optimizing business processes. However, existing research mainly addresses specific AI applications, while limited attention has been paid to comprehensive frameworks for the design of Expert Systems (ES) adapted to e-commerce environments. This research proposes a conceptual and methodological framework for the design, development, and implementation of ES-based solutions in e-commerce. Based on a critical review of the specialized literature and comparative analyses of existing approaches, including machine learning, deep learning, and large language models, the study identifies the current limits of existing research in the field and defines guidelines for the further development of ES adapted to the requirements as well as the possibilities of new generations of technologies. The proposed framework integrates computational, economic, and human-centered perspectives, contributing to a structured methodology for future intelligent, expert system-type applications orientated towards the e-commerce market. This paper is intended for researchers, software developers, and practitioners interested in e-commerce digitalization and intelligent solution development.

Keywords: Application of Expert Systems (ES), AI E-Commerce Solution, Conceptual Study, AI Subdomains Representation, ES vs AI approaches

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1 Introduction

The globalization phenomenon, framed in an era defined by the philosophy of society based on meta-knowledge and, as a result of it, also of a knowledge-based economy with prominent accents of "revolutionary technology and technological revolutions," is imposed not only by the presence but also through the need to interact with the finished products of high-performance technologies, marking the populations of countries around the world.

Technological transformations, in particular innovations from the ICT industry, bring with them new possibilities in all dimensions of human activity, a fact that is attested by many, including the following:

- *Science:* assistive technology policy analysis presented at the First Global Summit on Assistive Technology Research, Innovation, and Education [16] (MacLachlan et al., 2018); the impact of ICT on the biology of systems, but also their evaluation [4] (Petersen, 2016); Aspects of knowledge, capability, and innovation systems networks of global bioregions;
- *Education:* the research trends of the ICT integration phenomenon in education are reflected in a detailed bibliometric analysis [1] by Baako & Abroampa; various aspects of integration of ICT approaches and solutions in education at pre-university level [25], [31], [32] - [34], [37], [38], and university level have been examined by Burlacu [28] - [30], [36], [38]; information encryption technologies used in educational software for computerized knowledge testing [24] (Balmus & Burlacu, 2010); teaching science and technology as components of scientific literacy from the perspective of the stages of scientific inquiry [18] (Virtič, 2022);
- *Psychopedagogy* findings are reflected in the studies conducted by Muñoz et al. [44], Tuomivaara et al. [55], and particular didactics [26] - [28], [31], [32] - [35], and [38];
- *Economics:* Yu & Jin's transversal

theoretical study of applied economics on scientific research, technology, but also economic growth [62]; Remeikienė et al. analyze ICT development and the underground economy proving them through empirical tests conducted with reference to transition economies in the EU [52]; Turk [64] undertakes an analytical and structured study of ICT adoption in the European construction industry; Roztocki and Weistroffer [43] present an evaluative study of ICT in transition economies;

- *Industry*: Ziembra and Grabara [60] investigate the sustainability of ICT implementation in enterprises and the conditions affecting it; Kipper et al. [9] analyse the development of scientific mapping on Industry 4.0 using Scopus data from 2011 to 2018; Rao et al. in 2010 analyze ICT capital growth and multifactor productivity (MFP) in the global microfinance market [54], using empirical evidence from Canadian and US industries;
- *Others*, including some from and in the field of trade, in particular, that in the online environment, such as: Santos et al. [58]; Išoraitė & Miniutienė [14].

Concerning commercial transactions carried out with the support of digital technologies, we operate widely with the term e-commerce. Thus, in the general sense, but also recognized by the scientific community, e-commerce is a concept that designates a business where ICT products are implemented to bring profit to the business. This includes various sizes, including:

- those responsible for increasing sales;
- expansion of sales markets;
- offering new products and services;
- and also, those that involve the optimization of processes related to improving the quality of services.

The purpose of this research is to delineate the framework for the abstract design of expert systems (ES) in the e-commerce sector, especially, through the analysis of existing theoretical and applied studies on the size of IT solutions of the ES-type, which tend to respond to the needs of the e-commerce field.

1.1 The argument for the present study's actuality

The importance and potential of the present study emerge and can be demonstrated by the data provided by EuroCommerce, which represent arguments for the development and implementation of digital solutions in the service of employed persons as well as beneficiaries of the e-commerce sector.

EuroCommerce turns out to be an umbrella organization, which includes national associations from 27 countries and about five million companies, including top global players but also many small local businesses [4].

According to Delberghe [4] based on EuroCommerce statistics, "Over a billion times a day, retailers and wholesalers distribute goods and provide essential services to millions of businesses and individual customers".

Thus, the respective sector "generates one out of every seven jobs and offers a varied career to 26 million Europeans, many of them young people" [ibidem].

From the same source, we learn that the agreement itself, but also EuroCommerce, in fact, "supports millions of jobs throughout the supply chain, from small local suppliers to international businesses" [ibidem].

So, the number of indirect and direct final beneficiaries of some technological innovations on the dimensions of interest of the e-commerce sector would reach the level of billions of natural and legal persons, both in their capacity as employees or employers and in their capacity as consumers or buyers of the respective products, services, and/or technologies.

1.2 Scientific contribution and novelty of the research

We found that whilst numerous studies have investigated Artificial Intelligence applications in e-commerce, existing research predominantly focuses on isolated AI techniques, such as recommendation algorithms, machine learning-based prediction models, customer behavior analysis, or automated conversational agents. In any case, the given cluster of analyzed research has paid limited attention to the methodological framework required for designing Expert Systems specifically

adapted to the complexity of e-commerce environments, where, in today's era, technological, economic, and psycho-behavioral factors should interact with each other.

The scientific contribution of our research consists of proposing an integrated conceptual framework for the Expert Systems' design, development, and implementation in the e-commerce domain. Unlike previous approaches that analyses individual AI applications, the proposed framework combines three complementary perspectives: (1) the computational perspective related to ES architecture, knowledge representation, and inference mechanisms; (2) the economic perspective associated with e-commerce processes, market segmentation, and business objectives; and (3) the human-centered perspective considering customer experience, interaction, and decision-making behavior.

The novelty of the presented research consists in the integration of detected dimensions into a unified set of guidelines intended to support the development of ES-based solutions for e-commerce applications. Therefore, the actual study does not propose a specific commercial software product but a methodological foundation for future implementations and experimental developments of intelligent decision-support systems.

2 The research procedure

2.1 Materials and methods

Scientific methods such as:

- critical and descriptive analysis of scientific literature from peer-reviewed sources;
- the synthesis of reviewed and analyzed sources, these being monographs, articles from scientific journals from collections of international conferences, and analytical and/or statistical reports developed by companies specializing in data analysis related to the research spheres listed above (*Applied Informatics, Expert Systems, Artificial Intelligence*);
- the synthesized exposition of the studied scientific material, which is of an inter- and trans-disciplinary nature;
- the development of graphic representations: both Expert System and of the

development process of the proposed Expert System;

- the analysis of possible areas of application of this research:
 - for the development of expert system-type program products for serving e-commerce platforms;
 - for the methodology of training future specialists in the field of AI, ICT, software engineering, artificial intelligence, etc.;
 - for the foundation of the field of ES in the context of compatibility and adaptation to the existing technologies on the market;
 - and also, to the needs of the actors involved, in various forms of interaction, in the e-commerce field (owners, customers, employments (marketing staff; ICT developers' staff, etc.);
- creation of a graphic representation of guidelines related to the design, development, and implementation of ES in the e-commerce field;
- the treatment of the graphic representation related to the ES development condition guidelines for the e-commerce field.

2.2 Reasoning for developing SE-type AI IT solutions

The notion of Artificial Intelligence (AI) is becoming more common day by day. We hear about it from the mass media, TV news, information portals on social networks, and/or from the press run on the official channels of some giants in the ICT industry, and not only. The truth is that the concept of AI, whose overall genesis is analyzed below, includes an extensive typology of subcategories, the field of Expert Systems being one of them. AI systems are designed to analyze large amounts of data to recognize patterns and/or make decisions or predictions based on the analyses performed in various scientific fields and/or spheres of human activity, including:

- solving problems from various scientific branches such as mathematics, statistics, physics, chemistry, economics, sociology, etc.;

- medical, technical, financial, and/or economic, demographic, and/or sociological diagnosis, etc.;
- learning and reasoning;
- perception and understanding of natural languages;
- sound/speech recognition, facial, object, and/or image recognition, etc.

Although the subject of the classification of AI subfields is addressed in some scientific publications, by the authors as Cosic [11], Cadamuro [6], Majumder & Sen [53], the representations given by the listed authors are either fragmentary or detailed, but only for certain areas of scientific interest, thus also being limited. Thus, Burlacu proposed a diagram-style chart [38] that concurrently illustrates two generic classifications: a succinct version and a fully developed, exhaustive version. It should be noted that, since several attempts

have been made to represent AI subfields and many of these graphically share a certain degree of similarity—reflecting the contributions of multiple authors—identifying the primary source proved challenging. In particular, Mills [17] appears to be the original reference for the second classification, which, however, was neither explicitly named nor fully developed. Accordingly, the present study capitalizes on the elaborated double representation of the IA subdomains [38] (see Figure 1), invoking purposes such as: (1.) facilitating the comparison of the classification structures of the IA subdomains in both variants, succinct and extended; (2.) highlighting the evolution of AI subfields; (3.) the reflection of the opinion of the scientific community on the given field and, somewhere; (4.) the reflection of the trends in the development of the field of AI, but also of (5.) the scientific and para-scientific vision on the field of AI.

The Classification of Artificial Intelligence Subfields			
The IA subdomains set by classification 1: the brief version		The IA subdomains set by classification 2: the extensive version	
Natural Language Processing		Natural Language Processing	Classification
			Machine translation
			Question answering
			Content extraction
Fuzzy Logic		Machine Learning (ML)	Deep Learning
			Supervised
			Unsupervised
Expert Systems		Expert Systems	
Robotics		Robotics	
Neural Networks	Machine Learning	Neural Networks	
	Deep Learning		
		Vision	Image recognition
			Machine vision
		Speech	Speech to text
			Text to speech
		Planning	

Fig. 1. The Dual Representation of AI Subdomains [39]:

The classification 1 – The Brief Version versus 2 – The Extensive Version

It is clear from Figure 1 that:

- A. AI subdomains are undergoing transformation, in particular, in terms of integration and/or membership for certain categories with distinct properties that

characterize but, above all, distinguish one subdomain from another or others;

- B. Expert Systems approved as output of this research fall into a separate AI category.

2.3 Briefly about ES: concept and scope

We note that despite its periods of syncopated development, the field of AI managed to

assert itself not only in theoretical research, such as the development of AI capacity for determining and increasing the value of businesses, these being presented in a strictly theoretical framework [47] (Mikalef et al., 2019); meta-theoretical considerations regarding artificial intelligence [54], [49] (Wang, 2012), but also penetrated scientific fields with a pronounced application focus, such as the following: research on artificial intelligence and its applications [40] (Patil et al., 2023); development of AI applications [63] (Cao, 2017); evaluation of hybrid machine learning algorithms in online credit risk prediction [56] (Berhane et al., 2024); application of AI in tuberculosis detection [46] (Omodamilola et al., 2024); bi-modal emotion recognition [61] (Song & Zhou, 2024).

Moreover, we attest to opinions according to Burlacu (2023) [62]: "AI has successfully migrated, as other technologies had done many other times before, towards the social-economic environment focused only on business and/or the production industry technological and engineering; the field of transport and/or that of food safety; the fields of health and/or performing agriculture; the security and defense sectors and/or administration and public services, etc."

In this context, it also becomes obvious that when it comes to Artificial Intelligence, it is always necessary to specify the limits within which the discussion will take place or which subfields can be exploited in the sense of a subsequent and successful solution to the problem.

In our case, where the subject of the research is SE, it is clear that we fall into a special category in the field of AI.

Expert systems (ES) belong to a type of AI computer product that represents a computer program designed to solve tasks and/or problems of a particular nature using reasoning based on knowledge from a specific domain. This is, as a rule, the same field to which the task and/or problem originally formulated belongs. Initially, expert systems were developed for fields such as medicine [17] (Masic

et al., 1995); geology [57] (Schmoldt, 2006); chemistry [20] (Hemmer, 2007); and computer science [7] (Bennett, 1985). We consider that Expert Systems (ES) are programmable products capable of acting as advisors in solving problematic cases that require knowledge and/or expert human judgment to make it possible to combine all relevant factors leading to the generation of a decision that is maximally professional and competent. An expert system has a set of defining functionalities, such as:

- A. *Provides expertise*: an Expert System solves problems that typically require human expertise of a high professional level, provided in an interactive dialog with the user.
- B. *Appeals to symbolic processing*: In an Expert System, knowledge is represented in a conventional, nicknamed, and symbolic form. Later, that knowledge is called up and manipulated through special mechanisms specific to this type of IT product. The mechanisms in question are called inferences involving uncertainty.
- C. *Explains*: an expert system is equipped with the ability to clarify, explain, and argue, i.e., clarify its reasoning (its way of reaching conclusions).
- D. *Exhibit flexibility*: An expert system acquires knowledge incrementally. By supplementing and/or increasing his knowledge base, he becomes much more relevant in his area of expertise.

From the perspective of designing an Expert System-type computer product, in general, the development of any product of this type consists of a transposition of an accumulation of expert-level knowledge, tangential to a field of human activity, into a unique, functional computational system, developed using one of the programming paradigms specific to such a system, able to meet the demands of any user interested in clarifying controversies related to the universe of the problem or the main subject addressed by ES.

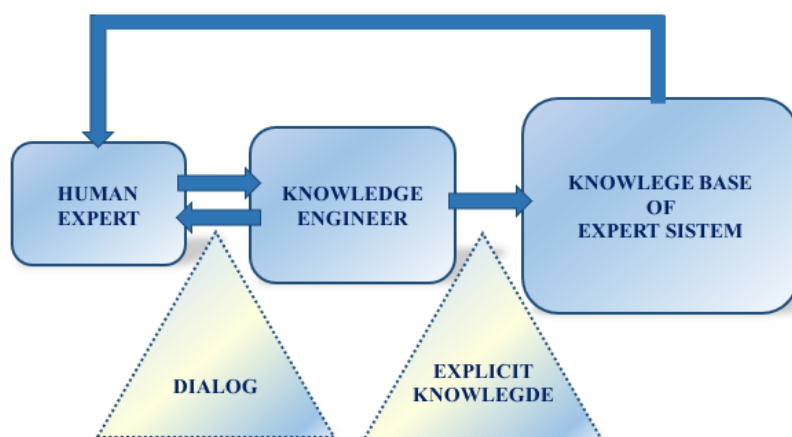


Fig. 2. Process of translating expert-level knowledge into an SE-type IT product

The respective transfer of knowledge is carried out by a specialist called Knowledge Engineer; to be explicitly analyzed in the representation below (see Figure 2).

An ES stores specialized knowledge and implements it at the request of the virtual user to support him in solving problems. As a virtual user, it can be both a natural person (a human

user) and another software system and/or even a mechanical device (a digital user). In turn, ES, being equipped with special procedures called inference procedures, implements the knowledge it possesses, which is stored as descriptive facts of the problem proposed for solution.

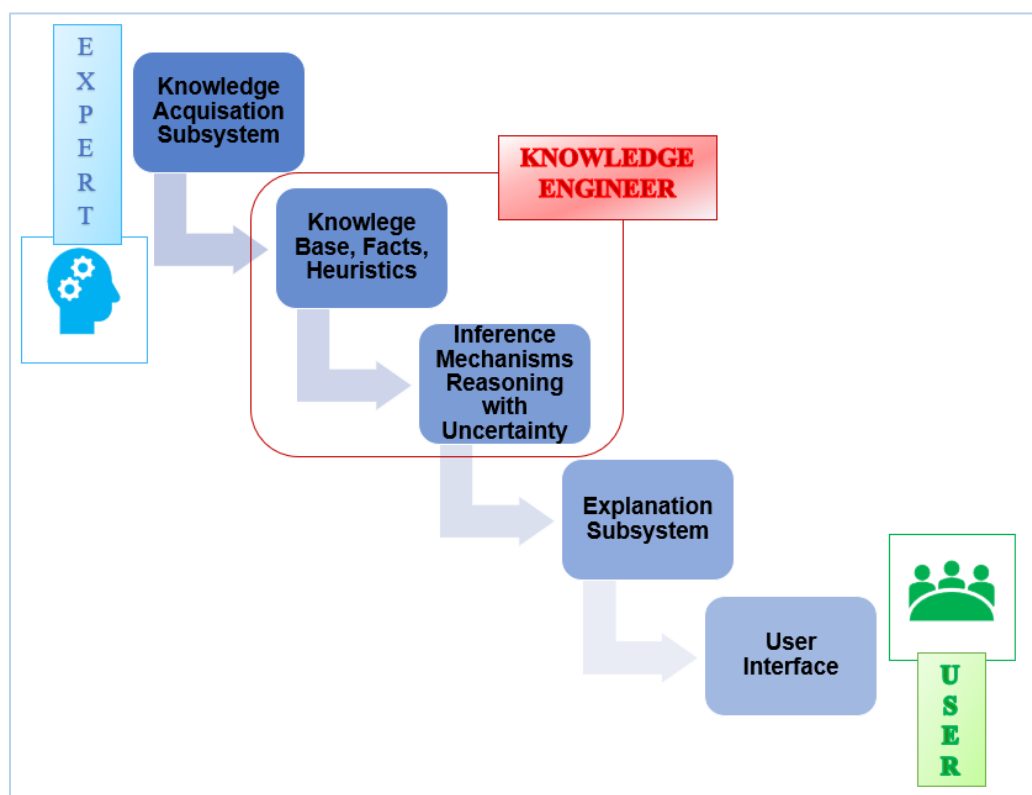


Fig. 3. The ES operation at the component interaction level

When applying the inference mechanism, conventionally speaking, the solution or set of solutions is generated, which can later be

consulted by viewing the computer screen. The functioning of an ES can be associated

with a process of interaction between distinct components (see Figure 3).

The knowledge base is called to store knowledge, using symbols and data structures designed to represent facts and relationships between facts within that ES.

An ES's knowledge can be presented in several ways. One of the most used is the production rule. The advantage of such an expression lies in the fact that, by using production rules, it is possible to express heuristic knowledge.

A knowledge base developed for a particular ES contains the sum of that knowledge that is necessary to solve problems specific to the problem universe determined by a particular ES.

The scientific literature indicates that the knowledge encoded in the rules of an expert system (ES) is declarative, as highlighted by Ogheneovo & Nlerum [45], Jibril et al. [15], Lachman [50] points of view. These are considered so because these are explicitly stated and are intended to be accessible to people

who might need to see them, for example, subject matter experts.

The ability to represent knowledge in an accessible, declarative, and descriptive form is one of the most important characteristics of an ES.

2.4 Expert Systems versus modern AI approaches

Modern artificial intelligence approaches offer remarkable capabilities. However, the Expert Systems offer more advantages in scenarios where transparency and explainability (Table 1), i.e., the extent to which decisions made by an algorithm can be understood, tracked, and justified, as well as domain-specific reasoning, are essential. In the field of e-commerce, where business decisions may require argumentation and adaptation to specific organizational rules, solutions based on SE can complement the treatments determined by machine learning and/or deep learning algorithms, which is more reasonable than replacing them.

Table 1. Comparison of AI approaches for e-commerce applications

Aspect	Expert Systems	Machine Learning	Deep Learning	LLM
<i>Knowledge source</i>	Human experts	Data	Large datasets	Massive text datasets
<i>Reasoning</i>	Explicit rules	Statistical patterns	Neural representations	Language-based reasoning
<i>Explainability</i>	High	Medium	Low	Variable
<i>Data requirement</i>	Low	High	Very high	Extremely high
<i>Domain adaptation</i>	Manual knowledge update	Retraining	Retraining	Prompt/fine tuning
<i>Suitable for e-commerce</i>	Decision support	Prediction	Image/customer analytics	Conversational commerce

Therefore, the methodological framework proposed by us presents Expert Systems not only as an alternative to contemporary artificial intelligence technologies but also as a complementary architecture capable of integrating knowledge-based reasoning with modern computational methods.

2.5 Review of specialized literature

Expert Systems, like any other scientific field, both from the perspective of its theoretical foundation and from that of its application implementation, have traveled a serious path in their development up to the modern stage, with theoretical and applied research being considered as starting points [12], [51] (Friedberg, 1958, as well as Friedberg et al., 1959).

In general, the period of 1988–2006 was full of early studies regarding the possibilities of expert systems in implementation areas such as:

- Expert systems for solving fiscal and accounting problems [2] – [3] (Brown, 1988; Brown & Phillips, 1995);
- Expert systems for selecting applicants for jobs in the area of human resources management [19] (Mehrabad & Brojeny, 2007);
- Expert systems designed to assess the impact of climate change and plan the process of adapting to these changes [60] (Qin et al., 2008);
- Expert systems specialized in construction quality management and auditing [10] (Lee et al., 2011).

If we are to comment on the situation in the areas tangential to our research, we notice that we do not have works that reflect with absolute precision the themes addressed by us in the present material, this being delimited by areas such as Expert Systems, E-Commerce, supporting the decision-making process of the customer. However, we find that in a series of scientific studies published in various countries around the world after 2000, Expert Systems are somewhat more varied from the perspective of their area of application, as follows:

Great Britain: A group of authors, led by Edwards (Edwards et al., 2000) is concerned with analyzing the activities involved in the decision-making process [8], the information requirements at three organizational levels, and the characteristics of expert systems intended to emulate the two roles of basis—to support and replace some decision factors. In their substantive work, findings were argued and enumerated, such as: (1.) expert systems in a replacement role proved to be effective in operational and tactical decision-making, although they detected certain limitations at the strategic level; and (2.) expert systems with a support role, in their capacity as advisory systems, can help to make better decisions, their effectiveness being possible to capitalize only through users.

Malaysia: Another team of researchers [42] (Rafidah et al., 2004) studying ES for the business environment, Business Expert System (BES), states that there are enough solutions developed in the software market to support the construction of ES for business, although in addition to a general analysis of the advantages of some ES intended for the business environment and, as well as their prospects, they do not come with a description of concrete solutions from those many approved in the abstract.

India: A recent and widely cited study [13] (Haleem et al., 2022) addresses complex interrelated topics similar to our research, i.e., the marketing valences of smart technologies, except that it broadly capitalizes on technologies of Artificial Intelligence (AI) and Machine Learning (ML).

The research in question is, in fact, a review of the scientific literature on the topic of AI in marketing. The sources analyzed by the authors were identified in Scopus, Google Scholar, and ResearchGate, as well as other platforms promoting scientific publishing activity. That paper examines specific applications of AI for various marketing segments from the perspective of the metamorphoses caused in the given marketing sectors, but their names are not transparent, which is not very good. In our opinion, the strength of that work lies in the exhaustive and critical analysis of applications intended for the field of AI in marketing, where a series of criteria are implemented that can be used as guidelines in the analysis of some products in the field.

Macedonia: Investigating the Influence of Artificial Intelligence on Business Value in the Digital Age of Strategy: a literature review by Perifanis and Kitsios [41].

Researchers from Romania publish papers related to the use and potential of AI in electronic commerce. Such are the case studies concerning:

- Geru et al. [12] discuss the development of e-commerce marketing strategies that utilize AI to analyze content generated by social media users;
- Valuing the performance aspects of electronic commerce, where applying

machine learning algorithms is done by Micu et al. [22];

- The analysis of the impact of the use of AI in online commerce in Romania is the focus of Micu et al. [22];

Thus, we can confidently state that early studies have highlighted the emergence of expert systems in e-commerce, focusing on rule-based systems for product recommendations. Those expert systems have demonstrated early success in improving user engagement and conversion rates, laying the foundation for further advancements in the field.

2.6 Comparative analysis of existing research limitations

Nevertheless, even though the comparative analysis conducted indicates that previous

studies have significantly contributed to the understanding of the specifics of the design and operation of AI applications and expert systems, we found that there are currently several limitations in this sense.

First of all, most of the existing works investigate isolated technological approaches, such as machine learning algorithms or recommendation mechanisms, without providing a comprehensive methodology for the design of complete Expert Systems (Table 2).

In this vein, our research focuses mainly on technical performance indicators, paying less attention to the interaction between technological architecture, business requirements, and customer experience.

Table 2. Comparative analysis of existing research and identified gaps

Study	Technology approach	Application field	Main contribution	Identified limitation
<i>Micu et al. (2019)</i>	ML algorithms	E-commerce	Performance prediction	Focus on algorithms, not knowledge-based systems
<i>Edwards et al. (2000)</i>	Rule-based ES	Business decision support	Decision support framework	Limited adaptation to digital commerce
<i>Rafidah et al. (2004)</i>	Business ES	Enterprise management	Analysis of ES advantages	No implementation methodology
<i>Haleem et al. (2022)</i>	AI/ML	Marketing	AI applications review	Does not address ES architecture

Hence, finally, existing research rarely addresses the complete life cycle of ES development, including conceptual modelling, knowledge acquisition, implementation, testing, improvement, and continuous maintenance of such products.

The identified limitations justify the need for the present research, in which we aim to provide an integrated framework for the design and implementation of ES adapted to e-commerce environments.

3 Dimensions and perspectives of ES field research

Based on the current state of things, when we witness on the market the increasing interest of various e-commerce companies in

digitization, it is worth noting that, in this sense, intelligent solutions are being sought to improve the interaction of commercial entities more or less visible online with customers, their current and/or potential.

3.1 The author's proposed guidelines for expert system development in e-commerce

Here we refer to the decision-making processes, the provision of positive customer and user experiences, as well as the overall efficiency of the entire set of professional actions that are resorted to in the occupational framework of their businesses.

The analysis of scientific literature carried out in the context of this research, as well as its results presented here, allow us to state that

the set of scientific reference materials, although they represent interesting studies for certain aspects tangential to the field of Expert Systems, however, does not cover all dimensions worthy of being taken into consideration both for the theoretical conceptualization and

for the computer implementation of this kind of program.

In our opinion, such research is necessary to be able to draw guidelines for the development of Expert Systems, in particular, for the e-commerce field, but not only (Figure 4).

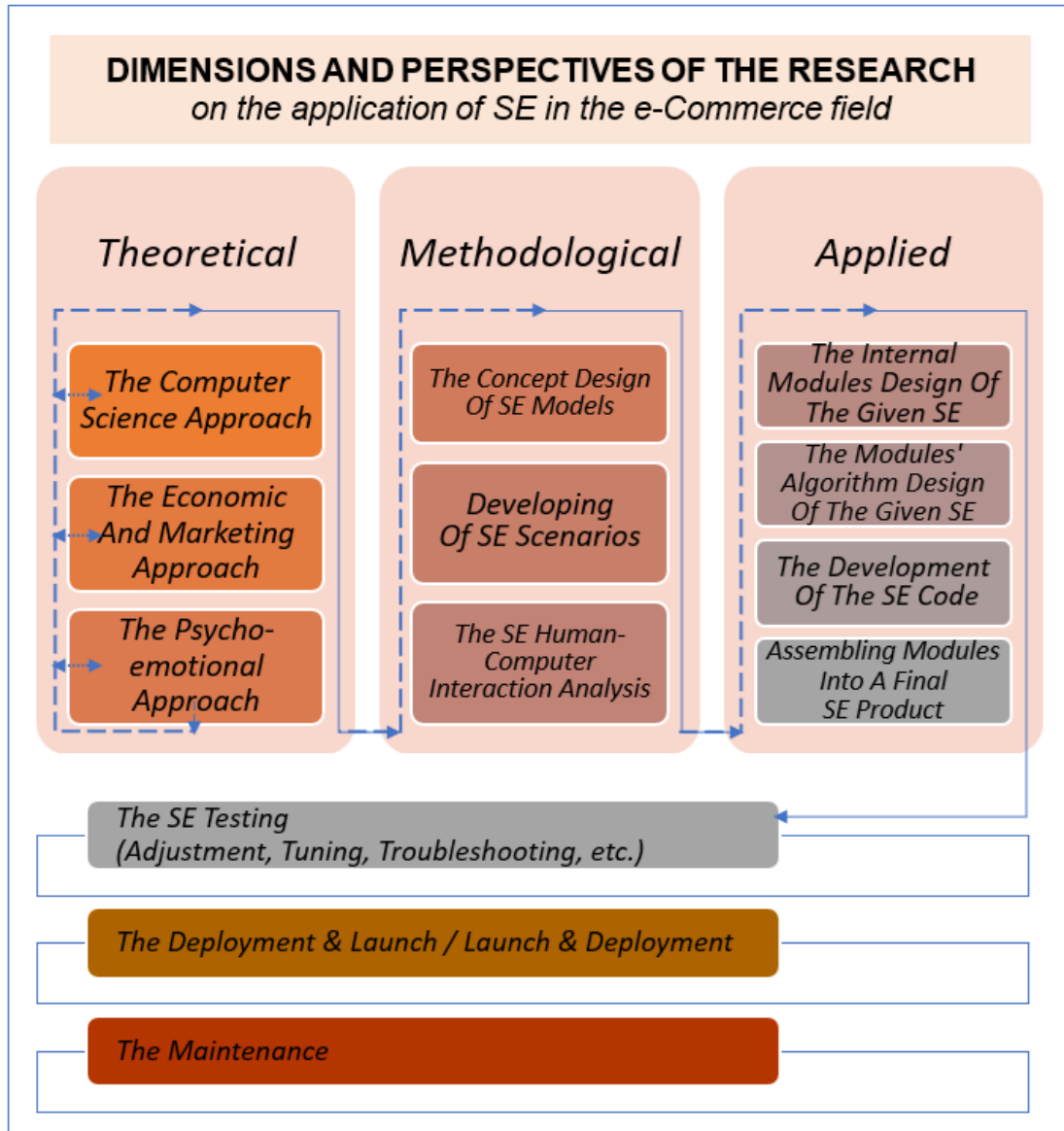


Fig. 4. Guidelines related to the design, development, and implementation of ES in the field of e-commerce

These are the following dimensions here.

A. Theoretical, which in turn would consist of several subordinate dimensions, such as:

- Informatics: concept model, prototype, Expert System, rules, facts, queries, etc.;
- The one of economic and market logical nature: e-Commerce; niche; segment; level: Premium / Medium, etc.;
- The psycho-emotional one: degree of satisfaction; personalized experience; excellence of experience: final beneficiaries, interested parties, involved in various transactions specific to the field of activity of the given economic entity, etc.

B. Methodology that would cover the aspects of

- Design of ES model concepts and models intended for implementation;
 - Development of scenarios for digital solutions, intended for the field of e-commerce, but not only;
 - Analysis of the interaction aspects (affective and/or cognitive, etc.) between the beneficiary, product or service, supplier or provider, and vice versa.
- C. Applied, it is good to include the levels of
- Internal design of modules to be integrated into data ES;
 - Algorithm design for modules to be integrated into ES data;
 - Developing, writing, and debugging the code for ES modules;
 - Assembling the created modules into a single, dedicated, secure ES.
- D. ES testing, which would also include adjustment, debugging of possible design and/or execution errors, etc.;
- E. Implementation & Release or Release & Implementation of the given software product;

- F. Long-term maintenance and continuous improvement of the created SE product.

Emerging from the complexity and composition of the dimensions described above, it is obvious the need to involve the design team of the ES product, whether it is equipped with AI or not, some specialists in the field of e-commerce, online, but also some experts who know about psychology, especially in social psychology and/or consumer psychology. Moreover, such approaches should be included as separate modules in the theoretical study of the professional training discipline at the university level, called in most faculties that prepare future specialists in the field of ICT, software engineering, applied informatics, etc. as Human-Computer Interaction.

3.2 Comparison between existing approaches and proposed framework

In this regard, a comparison was carried out between existing approaches and the proposed framework, the results of which were organized in a summary table (Table 3).

Table 3. Comparative analysis of existing expert system approaches and the proposed model

Criterion	Existing approaches	Proposed framework
Main focus	Specific AI application	Complete ES lifecycle
Knowledge representation	Rarely analyzed	Explicitly included
Customer psychology	Limited	Integrated
Business dimension	Partial	Included
Development stages	Fragmented	Design-development-testing-maintenance
Explainability	Not always considered	Core principle

From Table 3 it can be seen that existing visions generally address specific technological components of smart commerce solutions, while the proposed framework aims to integrate technical, economic, and human-centric dimensions into a unified development methodology.

4 The limitations and future directions are presented

Despite the theoretical, methodological, and conceptual contributions of this research, it is necessary to recognize its limitations, as follows: (A). The proposed framework

represents a conceptual methodology, which would require validation by developing and testing practical prototypes of Expert Systems, developed for virtual environments implemented in e-commerce; (B). The proposed guidelines do not evaluate the performance of a specific implemented system; therefore, future experimental studies should monitor indicators such as accuracy, usability, customer satisfaction, and business impact.

Future research directions will include the integration of Expert Systems with machine learning models, deep learning architectures, and large linguistic models to create hybrid

intelligent systems. Additionally, we believe that empirical studies involving e-commerce companies and/or end users are needed to validate the applicability and scalability of the proposed methodological framework.

5 Conclusions

Given the aspects, researched and described throughout the entire material presented in this paper, we can state with confidence that although the field of ES is not a cutting-edge one, one founded decades ago, it has a lot of gray areas that have not been sufficiently explored in scientific research so far. At the moment, given the expansion of digital and AI, as well as the expectation of the general public to actively interact with products able to cover their needs and expectations, we consider it premature to neglect the further development of the ES field.

In this context, it would be beneficial to integrate it into various fields of human activity, in particular e-commerce, where it could be of great support. Thus, Expert Systems, that use artificial intelligence offer the potential to revolutionize various aspects of e-commerce, from personalized recommendations to fraud detection.

From what has been analyzed and reported above, we can conclude that the field of development of Expert System products is sufficiently complex and vast, that once all aspects of design and implementation are taken into account, they allow the creation of interactive applications that are not only useful but also maximally close to the needs of the e-commerce field and satisfy the specific needs of the representatives of the parties interested in the development of the given field, which is not called e-commerce for nothing, or as Tobias Lütke, a German/Canadian entrepreneur, co-founder, and CEO of Shopify, said, "*E-commerce is not an industry; e-commerce is a tactic.*"

6 Competing interests' declaration

We have no conflicts of interest to disclose, and we can confirm that there are not any relevant financial or non-financial competing interests to report.

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