

# How reliance on GenAI might limit human creativity and critical thinking in Requirements Engineering

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## Abstract

Generative AI (GenAI) can greatly benefit Requirements Engineering activities by collaborating with humans and enhancing their creativity. On the other hand, GenAI tools are considered general-purpose AI models with systemic risk, partly because they can have a negative impact on human creativity and critical thinking. This paper presents the results of a literature survey to gather reported GenAI's potential negative impacts on creativity and critical thinking, which are then classified into risk categories. Said categories are then connected to specific articles and recitals in the Regulation (EU) 2024/1689 of the European Parliament and of the Council, also known as the Artificial Intelligence Act, which proposes high-level requirements and strategies to prevent or mitigate them. The results highlight gaps in existing regulations and guidelines, either because specific use cases are not considered, vaguely formulated, because of exceptions, or because some articles have not yet entered into force.

## Keywords

generative artificial intelligence, automation bias, mitigation strategies, trustworthy artificial intelligence

## 1. Introduction

The widespread adoption of Artificial Intelligence (AI) and Generative AI (GenAI) technologies is transforming marketplaces and decision-making processes. Among GenAI technologies, Large Language Model (LLM) based tools, such as ChatGPT, have gained prominence for their outstanding performance, accessibility, and affordability. Within Requirements Engineering (RE), many activities which typically rely on human creativity and critical thinking [1] have been enhanced with LLMs [2, 3, 4, 5, 6]. However, several risks associated with using GenAI exist. For instance, LLMs produce content in the form of human-like discourse personalized responses to users, which is widely considered to be one of the most effective persuasive messaging strategies [7]. This might lead to over-dependency on GenAI and GenAI-enhanced processes, potentially bypassing human critical or creative efforts [8, 9].

To better understand how the GenAI-enhancement of RE activities might negatively impact human creativity, this paper analyses the potential negative impact of GenAI across different sectors, as reported in the white and grey literature. The results are then discussed in the context of the Regulation (EU) 2024/1689 of the European Parliament and of the Council, also known as the Artificial Intelligence Act (AIA) [10], to extract approaches to harness GenAI's full potential while mitigating its possible negative effects and impact on human creativity and critical thinking. Through a comprehensive bibliometric analysis and a review of the retrieved literature, we aim to answer:

**RQ1)** How might reliance on GenAI enhance or limit creativity and critical thinking?

**RQ2)** What strategies can be found in the AIA to harness GenAI's benefits while mitigating its risks?

This paper is structured as follows: Section 2 summarises existing research on LLMs and AI-human interaction. Section 3 details the methodology used to extract the data needed for the analysis in Section 4, which presents the findings. Section 5 discusses the findings and future research directions.

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## 2. Background

LLMs are built upon deep learning techniques like Generative Pretrained Transformers (GPTs), and can produce useful natural language (NL) output. The emerging practice of using carefully selected and composed sentences to achieve the desired output is called *prompt engineering* [11].

### 2.1. AI's impact on creativity

To date, several studies have investigated the potential usage of GenAI for enhancing natural persons' creativity. For instance Feng et al. examines business applications and propose a framework to optimize GenAI's impact on employees' productivity, learning, and creativity [5]. The literature covers many diverse applications from digital storytelling [12] to curriculum design in education [13, 14], e.g. to increase student engagement [15]. Feng et al. state that, at an individual level, GenAI chatbots stimulate creativity by offering a continuous flow of suggestions and yielding insights for more innovative and effective solutions [5]. Habib et al. also report positive results when it comes to brainstorming or in elaborating simple ideas [6], and the AIA itself states AI can help acquire and share critical thinking [10]. However, Habib et al. also warn about the negative impacts of GenAI on creativity and thus advocate for a careful approach in integrating AI [6].

### 2.2. Automation bias

It is now well established that automation can bias decision-making, since humans tend over-rely on it even when warned that it might be faulty [16], and LLMs are trained to mimic human language and can confidently claim to have preferences, opinions, and beliefs. Anthropomorphism, e.g., generating human-like text, as well as system confidence and automation expertise [16] further fosters automation bias. Moreover, matching the language or content of a message to the psychological profile of its recipient is widely considered to be one of the most effective messaging strategies [7]. LLMs could accelerate this influence by making personalized persuasion scalable to spread of disinformation, manipulate political preferences, or promote specific consumer decision-making [7].

### 2.3. Trustworthy AI

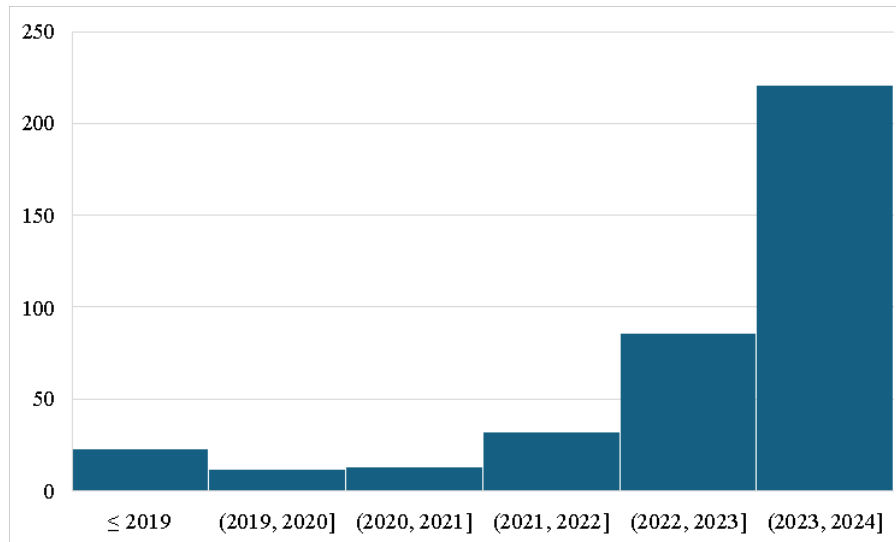
Trustworthy AI is a conceptual framework that ensures that the development and implementation of robust and ethical AI systems adhere to all the applicable laws and regulations, and conform to general ethical principles [17, 10]. International organisations have proposed AI guidelines for robust, ethical, and lawful AI development and use. For instance, UNESCO's recommendations on the Ethics of AI emphasise the need to understand and respect human rights and cultural diversity when developing AI systems, promoting *inclusiveness and social responsibility*, and ensuring *transparency and accountability* in AI decision-making [18]. Another example are the seven key requirements listed by the European Commission's High-level expert group on AI, that must be continuously assessed and managed throughout the entire life-cycle of an AI system, including *human agency and oversight* and *transparency*, among others [17, 10].

## 3. Methodology

The goal of the study is to identify the reported negative impacts in the academic literature of GenAI in human creativity and critical thinking, and map said potential impacts to concrete strategies present in the AI Act to mitigate them. This study was conducted in three steps.

### 3.1. Literature survey

Using the search string "*critical thinking*" AND "*creativity*" AND ("*generative artificial intelligence*" OR "*generative ai*" OR "*genAI*" OR "*gen AI*" OR "*large language model*"), 398 accessible documents (either



**Figure 1:** Exponential growth in publications mentioning both AI and human creativity or critical thinking after the popularisation of LLMs around 2022.

open-access or accessible through the authors' institutions) in English were retrieved from Google Scholar, out of which only 389 were articles. While we recognise that many articles in top-venues might not yet be accessible, in this study we assume that the mentioned risk types is the same than among the already accessible papers. This assumption might however, limit the validity of the results. All titles and abstracts were then used to filter out articles that do not mention AI and creativity or critical thinking in the title or abstract (either explicitly or implicitly).

### 3.2. Risk classification

The risks were then classified into categories, using a combination of deductive and inductive coding. During the inductive phase, the categories were combined based on set size and diversity on the discussed topics. This classification was used to report the positive and negative impacts of GenAI on human capabilities such as creativity and critical thinking. A bibliometric analysis was also conducted to quantify the research distribution through fields, based on their publication venue and the topics covered in each title and abstract, as a proxy for interest per field<sup>1</sup>. Moreover, complimentary risks were extracted from the AIA and jointly presented in Table 1.

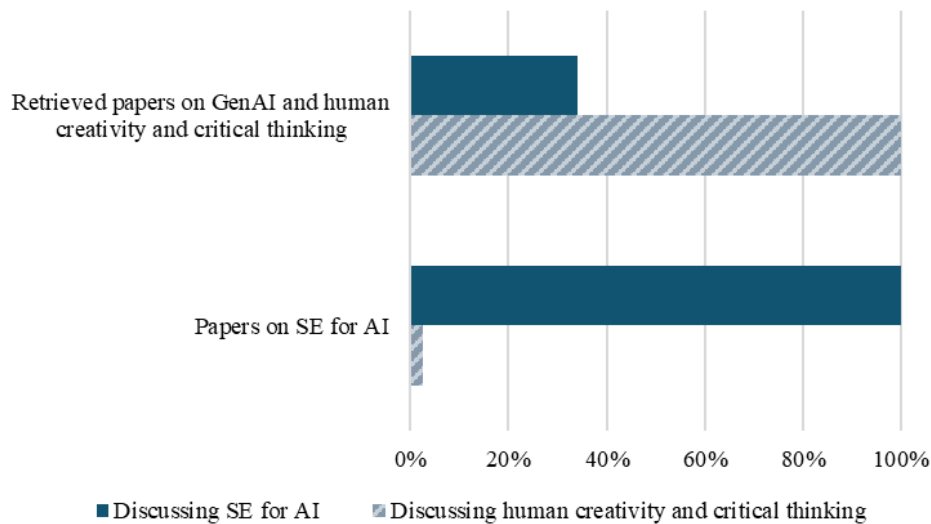
### 3.3. Mapping risks to mitigation strategies

Finally, the identified negative impacts were informally mapped to specific articles and recitals in the AIA, partly entered into force, to preliminary identify overlaps or gaps in regulation. The identified document parts were analysed with respect to the risks that GenAI might pose to human creativity and critical thinking. This preliminary analysis reveals some gaps, but (much) further work is needed to better understand the limitations of the European legislation for GenAI.

## 4. Results

GenAI's impact on creativity and critical thinking has received increasing academic attention in different fields. Using the search string detailed in Section 3, we retrieved relevant articles that were then analysed. The first observation is the exponential growth in publications after 2022, as seen in Figure 1, which coincides in time with the first public release of ChatGPT for the general public.

<sup>1</sup>Field labels for all retrieved papers in: <https://zenodo.org/records/14989798>



**Figure 2:** A small proportion of papers on SE for AI discusses human creativity and critical thinking.

The analysis also shows, as seen in Figure 2, that more of a third of the articles<sup>1</sup> focus on technical advancements in software, computing, and AI engineering. These include discussions on AI technologies (SE for AI) and AI applications in engineering fields (AI for SE), both AI development methodologies [19] and AI-enhanced software development methodologies [20, 21]. Most of these papers, however, also discuss GenAI application in a specific field. It is interesting to note that papers on technical advancements in software and AI seldom mention the potential negative impacts that these technologies can have on human creativity and critical thinking (approximately 3%), as seen in Figure 2.

Interestingly, the analysis also shows that 31% of the articles mention ChatGPT, which was not part of the search string, in the abstract. This proportion is even higher among papers on the use of GenAI in education, 61% of the retrieved papers, and out of these, 41% mentioned ChatGPT in the abstract. In contrast, the percentage of papers that mention ChatGPT among papers in other fields was 13%.

#### 4.1. Negative impact of GenAI on human creativity and critical thinking (RQ1)

The retrieved papers were analysed to extract the potential negative impacts of GenAI on human creativity and critical thinking. This analysis shows how GenAI's risks on critical thinking for consumers, companies, and the society have been discussed from different fields. The identified risks are then classified in four categories: (i) generation and spread of misinformation, (ii) over-dependency on AI, (iii) losing creativity-related skills, and (iv) the difficulty in distinguishing human creations from AI-generated outputs. A number of risks, listed in Table 1, were extracted from the literature and classified as belonging to one or more of these four categories.

##### 4.1.1. Generation and spread of misinformation

Almost one fifth of the retrieved papers<sup>1</sup> focus on the potential role of AI- or GenAI-based applications on the deliberate spread of false or misleading information. While GenAI models often excel at producing readable and informative content, they are often prone to the generation of hallucinations, by which GenAI tools might provide made-up and untruthful outputs, further contributing to the spread of misleading information [22]. Moreover, GenAI models on vast amounts of data retrieved from the internet, could produce discriminatory outputs, reinforcing stereotypes and biases [22]. These could deliberately manipulate public opinion [23] or cause reputational harms to the GenAI users [24].

Thus, users must carefully assess the reliability of AI-generated content, practising critical thinking [25]. This reinforces the need for users to be aware of the probabilistic nature of AI-generated

Risk	GSMI	DGAI	DIMC	IAIC	References
Subliminal stimuli generation	+				Article 5 (AIA)
Reinforce unfair biases	+				Recital 27 (AIA)
Simplistic generations lacking nuances of input data	+				[32]
Inability to trace outputs to training data	-				Article 12 (AIA)
Lack of human involvement in decisions		+			[29]
Lack of transparency makes human control challenging		+			Article 50 (AIA)
Unconsented surveillance and lack of privacy	-	-			Article 5 (AIA)
Pushing natural persons into unwanted behaviours or bias decision-making	-	-			Article 5 (AIA)
Bypassing critical reasoning efforts		-	-		[8, 9]
Automation bias makes humans seem less reliable	-	-	-		Article 14 (AIA)
Bypassing plagiarism detectors				+	[33, 34, 30, 22]
Identifying emotions in human content				+	Recital 44 (AIA)
Matter-of-fact yet incorrect generations	-			-	Article 5 (AIA)

**Table 1**

Risks extracted from the retrieved papers and the AIA classified into: generation and spread of misinformation (GSMI), over-dependency on GenAI (DGAI), diminishing creativity (DIMC), and indistinguishable human and AI creations (IAIC). A “+” symbol marks a clear connection to the category, while a “-” indicates an indirect relation.

responses. Reliance on GenAI-generated information without adequate human scrutiny could, for instance, lead to involuntary plagiarism [26].

#### 4.1.2. Over-dependency on GenAI

The second potential negative impact that is mentioned in the literature is over-dependency on GenAI, a growing concern in many fields, though mostly in education, based on the paper classification as described in Section 3<sup>1</sup>. In educational settings, for instance, over-reliance on GenAI could lead to students cheating [26] and putting students’ problem-solving skills at risk [27]. In many other contexts, individuals may also skip critical thinking or creative effort, relying instead on AI-generated solutions [8, 9].

#### 4.1.3. Diminishing creativity

While GenAI holds promise for humans to be more creative by offering new ideas, over-dependency on GenAI can lead, according to the scanned literature, to diminishing creativity and ability to generate original thoughts or designs. For instance, GenAI can reduce creativity by anchoring individuals on AI-generated concepts, stalling the generation of novel ideas [28]. This dependency on AI-generated content may lead to outcomes that lack originality which can also lead to diminished creativity skills. This risk, McGuire et al. state, dissipates when people co-create with AI tools instead of only editing their outputs [29].

#### 4.1.4. Indistinguishable human and AI creations

The last of the challenges related to GenAI and human creativity and critical thinking that we would like to highlight is the difficulty to distinguish human creations from AI-generated outputs.

Some GenAI models generate text that closely resembles human writing [30], making it harder to ensure originality and integrity in academic and creative fields [31]. This poses a variety of challenges, such as making it difficult to detect instances of cheating on exams and homework, which puts students’ problem-solving skills at risk [26].

### 4.2. Strategies in the AIA (RQ2)

The AIA states in *Recital 7* that in order to ensure the protection of public interest, rules for how AI systems can be “sold, used, and monitored in the EU” need be established [10]. These rules should take into account the existing laws, as well as the *Ethics guidelines for trustworthy AI* [17]. Moreover, the AIA defines some AI systems as high-risk and imposes extra requirements on them and on their human

operators. *Articles 5 and 6* and *Annex III* of the AIA outline how to classify high-risk AI systems. Some of the listed use cases lay very close to the applications in the literature, for instance:

- “Evaluate learning outcomes,” e.g., in graded student assessments as discussed in some of the education-related articles retrieved in the search.
- “Monitoring and detecting prohibited behaviour of students during tests,” such as plagiarism checkers, also commonly discussed in the literature<sup>1</sup>.
- “Establish priority in the dispatching of emergency first response services,” as healthcare virtual assistants, which are receiving increasing academic attention, could.
- “Assist a judicial authority in researching and interpreting facts and the law,” since it has been reported that nuances in the human-written texts are often lost [32].
- “Deploy subliminal techniques or purposefully manipulative or deceptive techniques,” either deliberately or not, contributing to the spread of misleading information.
- “Exploits any of the vulnerabilities of a natural person or a specific group of persons,” given that GenAI can reinforce unfair biases, as discussed in Section 4.1.

In light of the potential use cases for GenAI, and their potential negative impacts on human creativity and critical thinking, many **GenAI applications could be considered high-risk** systems following the AIA’s directives. Moreover, as per *Article 51*, GenAI tools are considered general-purpose AI models with systemic risk. High-risk or not, anyone who makes, uses, imports, or distributes GenAI systems in the EU must abide by the AIA<sup>2</sup>. But, what specific strategies does the AIA explicitly or implicitly propose that could mitigate the aforementioned threats?

GenAI applications, as discussed, could pose systemic risks which include, as listed in *Recital 110*, “the dissemination of illegal, false, or discriminatory content,” as discussed in Section 4.1. In the case of high-risk systems could lead to unintended harm, for instance leading over-dependent users to “erroneous decisions or wrong or biased outputs generated by the AI system,” as stated in *Recital 75*. As per the *Ethics guidelines for trustworthy AI*, these applications are considered high-risk systems and must be trustworthy and ethically sound in order to “minimise unintended harm.” To do so, concrete strategies are proposed such as ensuring that the GenAI-based tools are “are developed and used in a way that allows appropriate traceability and explainability,” which in turn allows for testing these systems in real world conditions to measure the **appropriate levels of accuracy and robustness**.

As part of the obligations for providers of GenAI tools, for being based on general-purpose AI models, *Article 53* and *Annexes IV, XI and XII* list providing transparency information and technical documentation to the GenAI users. These documents must contain a description of “the tasks that the model is intended to perform,” the “foreseeable unintended outcomes and sources of risks”, as well as “the evaluation strategies, including evaluation results.” These documents could help users identify the limitations of GenAI applications, and potentially **reduce automation bias and over-dependency** on these models. The technical documentation must also contain the “known or estimated energy consumption of the model,” that can be “based on information about computational resources used.” This could partially answer the questions posed in 2023 by Mercier-Laurent on balancing AI usage with human and planetary sustainability [35].

*Article 50* imposes on GenAI systems that interact directly with natural persons to be designed and developed in such a way that users “are informed that they are interacting with an AI system,” and that GenAI’s outputs need be disclosed or detectable “as artificially generated or manipulated.” While these transparency obligations for GenAI application providers are a clear step to **help distinguish human creations from AI-generated outputs**, there are a number of clauses that could threaten this strategy such as the vague description of the exceptions. For instance, this obligation shall not apply where the use is “evidently artistic, creative, satirical, fictional” or where the generations undergo “a process of human review or editorial control;” in those cases, the editor or reviewer, a natural person,

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<sup>2</sup>The AIA does not apply AI applications for military, defence, or national security purposes; nor to AI systems released under free and open-source licences, unless they are high-risk AI systems.



“holds editorial responsibility.” In those cases, the use of GenAI must be informed “in an appropriate manner,” which leaves room for interpretation.

These obligations, making a natural person responsible for the generations, could also indirectly **reduce the misinformation and made-up content** that GenAI is susceptible to generate. People must, as McGuire stated in 2024, occupy the role of a co-creator, not just an editor [29], to reap the benefits of GenAI while mitigating the systemic risks it poses.

However, there are gaps yet to be covered by existing laws, regulations, commitments, and guidelines, either because specific use cases are not considered, because exceptions exist or the scope is vaguely formulated, or because the appropriate articles have not yet entered into force.

## 5. Discussion and conclusion

The many applications and use cases that GenAI has, or might have in the future, can contribute to a wide array of RE activities, creative processes that greatly benefit from creativity techniques [1]. However, GenAI models often answer in a “human-like” and confident way, which can lead to over-reliance, even though the generation might be made-up or untruthful [3]. Moreover, GenAI usage in RE can also be an impactful negative factor for creativity and critical thinking, since it often stalls the generation of novel ideas [28, 29]. The potential negative impacts of GenAI on creativity and critical thinking, as reported in the literature, were analysed in Section 4.1 and categorised, addressing RQ1, as:

**Insight:** The identified risks can be related to the generation and spread of misinformation, over-dependency on AI, the risk of losing creativity-related skills (especially by students), and to the difficulty in distinguishing human creations from AI-generated outputs.

As general-purpose AI models with systemic risk, as defined by the AIA, the deployment and use of GenAI models that can negatively affect human human creativity and critical thinking must be accompanied by a set of mitigation strategies. However, there are gaps yet to be covered by existing laws and guidelines. To the best of the authors’ knowledge, there is no mitigation strategy is explicitly or implicitly present in the AIA for these risks, as reported in Section 4.2. Addressing RQ2:

**Insight:** There is no mitigation strategy is explicitly or implicitly present in the AIA for some of the risks that GenAI poses on the creativity and critical thinking of natural persons.

When analysing the research distribution and focus across various fields, the most striking result was that 61% of the retrieved papers are about education and students’ use of GenAI. Out of these papers, 41% mentioned ChatGPT in the abstract. This highlights the importance that a particular GenAI tool can have. In this regard, the authors would like to highlight the need for interdisciplinary research when developing policies or recommendations aimed at ensuring the responsible and effective integration of *different* GenAI models and tools in *different* settings, including but not limited to the ones here.

## Declaration on Generative AI

The authors used OpenAI GPT-4o and Meta Llama in order to paraphrase and reword, and for grammar and spelling check. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication’s content.

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