# AI and Socio-Technical Transformation in the Creative Digital Industries

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**Abstract**
Artificial Intelligence (AI) is increasingly reshaping the creative digital industries, including visual effects (VFX), animation, game development and digital visualization. While AI-assisted tools create new opportunities for production acceleration, automation and creative experimentation, they also raise questions concerning changing workflows, professional roles, employability and skills development. This paper examines AI integration in the creative digital industries of North Macedonia through a socio-technical perspective, focusing on the interaction between technological change, human creative work and organizational production practices. The study is based on ten semi-structured interviews with purposively selected organizational representatives from relevant segments of the sector and applies thematic and narrative analysis. The findings indicate that AI is primarily perceived as a technology that supports and accelerates particular production tasks rather than as a direct substitute for human creativity. At the same time, its integration contributes to the redistribution of tasks and changing competency requirements, while creative judgment, problem solving, teamwork and interdisciplinary collaboration retain strong importance. The findings also reveal a gap between formal educational preparation and rapidly evolving industry requirements, alongside a strong reliance on informal and self-directed learning. The paper argues that AI-driven transformation in creative digital industries should be understood as a broader socio-technical reconfiguration involving technologies, workflows, workforce structures, skills development and globally connected production environments.

**Keywords**
Artificial Intelligence (AI), Creative Digital Industries, Socio-Technical Systems, Human Resource Management, Workforce Transformation, Skills Development.

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## Introduction

The creative digital industries represent one of the fastest-growing segments of the contemporary knowledge-based creative economy, combining artistic creativity with advanced technological production processes [1]. Sectors such as VFX, animation, game development and digital visualization increasingly operate within interconnected production environments shaped by software infrastructures, collaborative workflows and global digital networks.

In recent years, AI-assisted technologies have become increasingly integrated into these environments. Generative AI tools, automated asset creation systems and machine-assisted workflows introduce new possibilities for production acceleration, experimentation and productivity enhancement, while simultaneously raising questions concerning the organization of creative work, employability, professional expertise and human creative agency [2, 3]. Their significance therefore extends beyond the adoption of individual technological tools, as AI may also influence task distribution, workflow coordination, skill requirements and the interaction between human expertise and technological infrastructures.

Socio-technical perspectives provide an appropriate framework for examining these transformations because technological systems cannot be understood independently from the organizational, social and labor contexts in which they operate [4-6]. From this perspective, AI

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is treated as one component of a broader production system in which technologies, creative professionals, organizational arrangements, skills and market conditions continuously interact. The analytical focus therefore extends beyond whether AI is perceived as beneficial or threatening toward understanding how its integration may reshape the relationship between technological and social dimensions of creative production. Previous socio-technical research in the Macedonian context has also examined technological preferences, human-centered work design and digital HRM systems in technology-intensive organizations [7-9].

This perspective is particularly relevant to the creative digital industries in North Macedonia. The sector includes predominantly locally established companies and studios operating within global markets and internationally connected production environments. Their work is often project-based and organized through flexible and interdisciplinary teams, while technological change, international competition and rapidly evolving skill requirements create a continuous need for adaptation.

Although still a relatively young ecosystem, the Macedonian creative digital sector has demonstrated notable international engagement and visibility relative to the size of the country. The VFX segment developed early international visibility, with locally established studios contributing for many years to major international and Hollywood productions [10]. The game development sector has followed a similarly outward-oriented trajectory: earlier mapping found that Macedonian Global Game Jam events ranked fifth worldwide in participants per million inhabitants, while locally developed games were already distributed across major global platforms, including Steam, Xbox, Nintendo Switch and PlayStation [11]. This combination of an emerging domestic ecosystem, early international integration and demonstrated creative-technological capacity makes the Macedonian context particularly relevant for examining how new technologies such as AI are incorporated into creative production.

Against this background, the paper examines the integration of AI into creative digital production and the associated transformations in workflows, workforce structures and skill requirements. Rather than approaching AI through a binary narrative of technological optimism or technological threat, the analysis considers AI as part of an evolving socio-technical production environment in which human creativity, technological infrastructures and organizational practices interact.

## Research Methodology

The analysis presented in this paper is based on ten semi-structured interviews (n=10) conducted between February and March 2026 with representatives of companies operating in the creative digital industries in North Macedonia. The interviewed organizations represent several segments of the sector, including film and television VFX production, animation, game development and digital 3D production. While each company maintains a primary production focus, many studios operate across multiple interconnected activities such as animation, visualization, simulation, interactive media and post-production.

The study follows a qualitative research design. The sample was purposively constructed to include organizational representatives with direct knowledge and experience of production processes, workforce requirements and technological developments within the sector. Respondents included producers, directors, founders, talent acquisition managers and other management representatives from micro, small and medium-sized studios, together with one large international company operating in the game development sector. The purpose was not

to obtain statistical representation of the population of creative-industry professionals, but to obtain information-rich organizational perspectives from appropriately positioned representatives across relevant segments of the sector. This is particularly appropriate in the context of a relatively small and interconnected national creative digital ecosystem, in which a limited number of companies and organizational actors possess direct experience of internationally oriented digital production.

The interviewed companies operate predominantly from North Macedonia while participating in global markets and internationally connected production networks. Their market orientation varies across companies and subsectors, and the analysis therefore treats global integration as an important characteristic of the production environment rather than assuming dependence on any single geographic market or client network.

The study applied thematic and narrative analysis of the interview data. For the purposes of the present paper, recurring themes were interpreted through a socio-technical perspective, focusing on the interaction between technological change and dimensions such as production organization, professional roles, skills, employability, learning practices and project-based work. This analytical framing enables the findings to be examined not simply as individual attitudes toward AI, but as organizational experiences of technological change within evolving creative production systems.

In addition to the qualitative analysis, selected numerical responses and competency evaluations collected within the interviews were summarized through descriptive mean values. All structured ratings were measured on a five-point scale ranging from 1 (lowest) to 5 (highest), with higher scores indicating a higher level of the assessed attribute. Given the small sample size and qualitative research design, these values are not intended for statistical inference or population-level generalization. They are used solely as descriptive indicators supporting the interpretation of recurring patterns related to workforce preparedness, skill requirements and learning pathways.

Organizational and respondent identities were anonymized in order to ensure confidentiality and reduce the possibility of indirect identification.

In this context, the paper addresses the following research questions:

- RQ1: How is the integration of AI reshaping creative production workflows and the interaction between technological tools and human creative work within the creative digital industries?
- RQ2: What organizational and operational opportunities, tensions and uncertainties emerge as AI becomes integrated into project-based and globally connected creative production environments?
- RQ3: How does AI-related transformation affect workforce structures, employability and skill-development requirements within the socio-technical ecosystem of the creative digital industries?

## Creative Digital Industries as Socio-Technical Production Systems

The findings indicate that the creative digital industries in North Macedonia function less as a single homogeneous industry and more as a dynamic ecosystem of interconnected creative and technological activities. Many companies combine artistic, technical and interactive forms of

digital production within the same organizational environment, reflecting the increasingly hybrid character of contemporary creative work.

From a socio-technical perspective, this production environment can be understood through the interaction of two closely connected dimensions: the technical subsystem and the social subsystem [5, 6, 12]. The technical subsystem includes industry-standard software environments used in VFX, animation and game development, including Maya, Blender, Houdini, Nuke, Unreal Engine and Unity, as well as collaborative production and asset-management platforms such as ShotGrid, rendering and visualization technologies, and increasingly AI-assisted applications used at different stages of creative production. The social subsystem includes creative and technical professionals, interdisciplinary teams, organizational roles, project-based working arrangements, professional knowledge and skills, and the learning practices through which workers adapt to technological change.

These two dimensions are not independent. Production outcomes depend on their continuous interaction: technological tools influence how tasks are organized and coordinated, while professional expertise, creative judgment and organizational practices shape how technologies are selected, interpreted and integrated into actual production processes. AI therefore enters an already complex socio-technical environment rather than replacing a previously technology-independent form of creative work [12]. This reflects the classic socio-technical principle of joint optimization, whereby sustainable performance depends on aligning technical efficiency with human and organizational requirements rather than optimizing either subsystem in isolation [5, 6].

The sector is strongly shaped by project-based production logic. Companies frequently organize teams and workflows around specific projects, contracts or production tasks, requiring adaptability, interdisciplinary collaboration and the capacity to respond rapidly to changing technological and market requirements. At the same time, many companies based in North Macedonia operate in global markets and participate in internationally connected production networks. These connections expose local studios to evolving technological standards, client requirements and competitive pressures, but also provide access to international projects, knowledge flows and production practices.

The findings further suggest that professional roles increasingly transcend traditional disciplinary boundaries. Creative professionals are often expected to combine artistic judgment with technical proficiency, workflow awareness, communication and collaborative problem solving. Consequently, professional competence is increasingly defined not only by mastery of a particular software tool or creative discipline, but by the ability to operate effectively within integrated production systems in which technological and human components are closely interdependent.

In this sense, digital creativity should not be understood simply as artistic activity supported by technology. It is produced within organizationally structured and technologically mediated environments in which creative agency, technical infrastructures and collaborative practices continuously interact. This socio-technical interdependence provides the analytical basis for examining how the introduction of AI may reshape workflows, professional roles and the organization of creative labor in the sections that follow.

## AI Between Creativity and Automation

Artificial Intelligence emerges from the interviews as one of the most significant technological developments currently influencing the creative digital industries. Respondents describe AI not as a single disruptive technology, but as a growing set of tools entering different stages of production and gradually reshaping creative and technical workflows.

AI-assisted applications are primarily associated with concept generation, image manipulation, asset creation, workflow automation, rendering support and production acceleration [2, 3]. Employers generally do not perceive these technologies as a complete replacement for professional expertise or human creativity. Instead, AI is primarily understood as a tool that can support or accelerate particular production tasks while changing how creative work is organized and executed [13].

From a socio-technical perspective, AI can therefore be understood as a boundary-shifting technology that gradually redistributes tasks between the technical and social components of the production system [12, 13]. As certain repetitive, standardized or technically intensive activities become increasingly supported by automated tools, the role of creative professionals may shift toward activities requiring interpretation, creative judgment, contextual understanding, coordination and decision-making. AI adoption therefore affects not only technological workflows, but also the distribution of professional responsibilities and the competencies that remain particularly valuable within production teams.

The competency evaluations reinforce this interpretation. Employers assign the highest importance to teamwork (m=4.4), software proficiency (m=4.4), design principles (m=4.3) and problem solving (m=4.2). These findings suggest that technological competence remains essential, but its value is closely connected with creative, relational and problem-solving capabilities. In increasingly AI-assisted environments, professionals are therefore expected not simply to operate technological tools, but to integrate them effectively within collaborative production processes.

At the same time, respondents recognize uncertainty regarding the implications of AI for particular categories of work. Tasks characterized by repetition, standardization and technical routine are perceived as more exposed to automation, while activities dependent on creative judgment, visual storytelling, interdisciplinary collaboration and contextual decision-making are considered less easily substitutable.

The findings therefore point to a transformation of professional roles rather than a straightforward replacement of human creative labor. The boundary between human and technological contribution becomes increasingly fluid as AI tools are incorporated into existing workflows, but human expertise continues to play a central role in determining how technological outputs are interpreted, evaluated and incorporated into creative production.

This relationship between creativity and automation should consequently not be reduced to a binary opposition between human and machine labor. AI increasingly functions as an embedded component of a broader socio-technical production system in which creative professionals, technological infrastructures and organizational workflows continuously interact. The central issue is therefore not whether AI eliminates human creativity, but how its integration changes the distribution of tasks, professional competencies and forms of human–technology collaboration within creative production.

## Workforce Transformation and Skills Ecosystems

One of the strongest themes emerging from the interviews concerns workforce transformation and the changing nature of employability within the creative digital industries. Respondents consistently distinguish between basic familiarity with industry-standard production software and the broader capacity to perform effectively within professional production environments.

This distinction becomes particularly important in AI-assisted production environments. As some technical tasks become increasingly automated or supported by intelligent tools, professional value is likely to depend less on isolated execution skills and more on the ability to combine technological proficiency with creative judgment, adaptability, collaboration and problem solving. Employability therefore develops through the interaction between technical competence and the social and organizational requirements of production.

The practical relevance of AI competence is particularly visible in game development. One respondent estimated that AI-assisted tools are involved in approximately 90% of the company's current production workflow and noted that the company specifically seeks candidates who are able to use such tools effectively. Although this represents the experience of a single organization, it illustrates how AI proficiency is beginning to shift from an additional technical advantage toward an explicit employability criterion in parts of the sector.

More broadly, the findings indicate that professional competence within the sector is inherently multidimensional. Successful professionals are expected to combine software proficiency with design knowledge, communication, teamwork, problem solving and awareness of production workflows. In this sense, technological change does not reduce the importance of human expertise, but contributes to a continuing redefinition of the forms of expertise required within digitally mediated creative work [14].

The interviews also identify an important gap between formal educational preparation and the rapidly changing requirements of industry. Employers evaluate overall workforce preparedness at a moderate level (m=3.1), while the capacity of formal education to prepare graduates for industry requirements is evaluated similarly (m=3.0). By contrast, informal and self-directed learning receives the highest evaluation (m=4.5).

These findings should not be interpreted as evidence that formal education has become irrelevant. Respondents emphasized that formal education provides an important foundational understanding of how technologies, systems and underlying scientific principles operate, particularly in engineering and related technical fields. However, formal qualifications alone may be insufficient in a sector characterized by rapid technological change and continuously evolving production practices. Non-formal training, self-directed learning, online learning resources and workplace experience therefore build upon this foundation by supporting the continuous updating and practical application of knowledge and skills. Formal and informal learning pathways thus appear to perform complementary rather than competing functions in professional development.

From a socio-technical perspective, this pattern points to the importance of stronger alignment between technological change, educational provision and workplace learning. As production technologies evolve, skills development cannot be treated as a one-time process completed before entry into employment. Instead, it increasingly becomes a continuous process in which individual learning, organizational adaptation and technological development interact [15, 16]. Earlier research in the Macedonian context has similarly emphasized continuous and

lifelong learning as a mechanism for adapting to technological and broader changes in the world of work [17], while subsequent research identified a strong positive association between attitudes toward new communication technologies and continuous learning [18].

AI further intensifies this dynamic by accelerating changes in tools, workflows and task structures. This may create particular challenges for early-career professionals if routine production tasks traditionally associated with entry-level learning become increasingly automated. However, the present study does not provide sufficient evidence to determine the scale or long-term consequences of such changes. This represents an important direction for future research on career entry, skills formation and professional development within AI-assisted creative industries.

The findings therefore support the development of adaptive learning ecosystems that connect formal education, non-formal training, self-directed learning and workplace-based experience. The key socio-technical challenge is not to replace one learning pathway with another, but to improve their interaction so that technological innovation is accompanied by corresponding opportunities for professional learning, skill development and sustainable employability [15, 16].

## AI, Global Competition and Market Uncertainty

Although respondents recognize the productivity potential of AI, the interviews also reveal important concerns regarding its broader economic and organizational implications. These concerns are particularly visible in sectors such as VFX, animation and other internationally oriented forms of digital production, where technological change takes place within already dynamic and highly competitive global markets.

Several respondents describe the VFX sector as having experienced considerable instability in recent years as a result of multiple overlapping developments, including the COVID-19 pandemic, disruptions in international audiovisual production, the Hollywood writers' and actors' strikes, the shift toward streaming-platform production, which respondents associated with more constrained budgets for visual effects compared with major Hollywood productions, and intensified international competition. In this context, some respondents specifically point to growing pressure from large international production markets such as India, which they described as combining lower labor costs with large-scale production capacity, thereby creating strong price competition within global VFX and digital production networks. AI-assisted production may further influence these dynamics by increasing expectations regarding production speed, scalability and cost efficiency.

The implications of these developments, however, extend beyond technological efficiency. From a socio-technical perspective, changes in production technologies interact with market conditions, organizational strategies and workforce arrangements. Companies must continuously balance technological adaptation with the maintenance of creative quality, professional expertise and sustainable production processes [12, 19].

Respondents also identify particular uncertainty concerning tasks characterized by repetition, standardization and technical routine, which may be more susceptible to automation. At the same time, roles requiring creative judgment, interdisciplinary coordination, visual interpretation and complex problem solving continue to be perceived as strongly dependent on human expertise. AI may therefore alter the relative value and organization of different forms of work without necessarily eliminating the need for creative professionals [13, 19].

These dynamics are especially relevant for companies operating in global markets, where technological development and competitive pressures evolve simultaneously. Participation in international production networks creates access to global projects, knowledge and technological practices, while also exposing companies to changing client expectations, international competition and shifts in production models. AI becomes one additional factor within this broader environment of continuous adaptation.

The findings therefore suggest that the effects of AI cannot be understood independently from the organizational and market contexts in which technological adoption occurs. AI-assisted production is intertwined with wider changes in project organization, workforce requirements, competitive conditions and global digital production. Its socio-technical significance lies not only in the automation of particular tasks, but in the way technological change interacts with existing production structures and contributes to the continuing reconfiguration of creative work.

## Conclusions

This study examined the integration of Artificial Intelligence (AI) within the creative digital industries of North Macedonia through a socio-technical perspective. The findings indicate that AI is becoming embedded in creative production not as an isolated technological disruption, but as part of a broader transformation involving production workflows, professional roles, skill requirements, organizational practices and globally connected markets.

The central finding is that AI-related transformation does not primarily concern the disappearance of human creativity. Rather, it concerns the changing relationship between technological capabilities and human contribution within creative production systems. AI-assisted tools can accelerate or automate particular tasks, especially those characterized by repetition and standardization, while creative judgment, problem solving, interdisciplinary collaboration and contextual decision-making continue to retain strong human value.

From a socio-technical perspective, the study therefore highlights the importance of examining technological and social change together [5, 6]. The introduction of AI modifies technical possibilities, but its organizational consequences depend on how technologies are incorporated into workflows, how professional roles adapt and how skills are developed.

The findings demonstrate that technological innovation cannot be evaluated independently from the workforce structures, learning practices and market environments within which it is implemented. In socio-technical terms, the central challenge is therefore one of joint optimization: aligning AI-enabled technical efficiency with human expertise, learning and sustainable forms of work organization.

A second important finding concerns the skills ecosystem surrounding creative digital work. The moderate evaluations of workforce preparedness (m=3.1) and formal educational preparation (m=3.0), together with the high importance attributed to informal and self-directed learning (m=4.5), indicate a need for stronger interaction between formal education, non-formal learning, workplace experience and continuous professional development.

The game development case further illustrates how AI proficiency is beginning to emerge as an explicit employability criterion in parts of the sector, reinforcing the importance of continuous adaptation to rapidly evolving production technologies. Rather than suggesting the replacement of formal education, these results point toward the development of more adaptive

learning ecosystems capable of responding to changing technological and professional requirements [15, 16].

The study also demonstrates that AI transformation within the creative digital industries is embedded in wider market dynamics. This is particularly relevant in the Macedonian context, where a relatively young but internationally connected creative digital ecosystem participates in global production environments characterized by international competition, evolving production models and rapid technological change. AI therefore represents one element within a broader process of organizational and market adaptation rather than an independent determinant of sector development.

The theoretical contribution of the paper lies in applying a socio-technical perspective to creative digital industries as hybrid production systems in which creative agency, technological infrastructures, organizational arrangements and skills development are closely interconnected. In this context, AI can be understood as a technological component that contributes to the reconfiguration of task boundaries, professional competencies and forms of human–technology collaboration. This extends the application of socio-technical analysis to creative digital industries characterized by project-based work, interdisciplinary production and continuous technological experimentation.

The study is exploratory and qualitative, based on ten semi-structured interviews with organizational representatives from relevant segments of the creative digital industries in North Macedonia. Its purpose is therefore analytical rather than statistically generalizable. Future research could build on these findings through larger comparative studies, longitudinal research on changing professional roles and career pathways, and more detailed investigation of how AI affects entry-level work, skills formation and organizational learning over time.

Future competitiveness in the creative digital industries will depend not only on the adoption of increasingly advanced technologies, but on the capacity of organizations, professionals and learning institutions to adapt together. The key socio-technical challenge is therefore to ensure that technological development is accompanied by corresponding development of human expertise, organizational capabilities and sustainable pathways for professional learning within AI-assisted creative production.

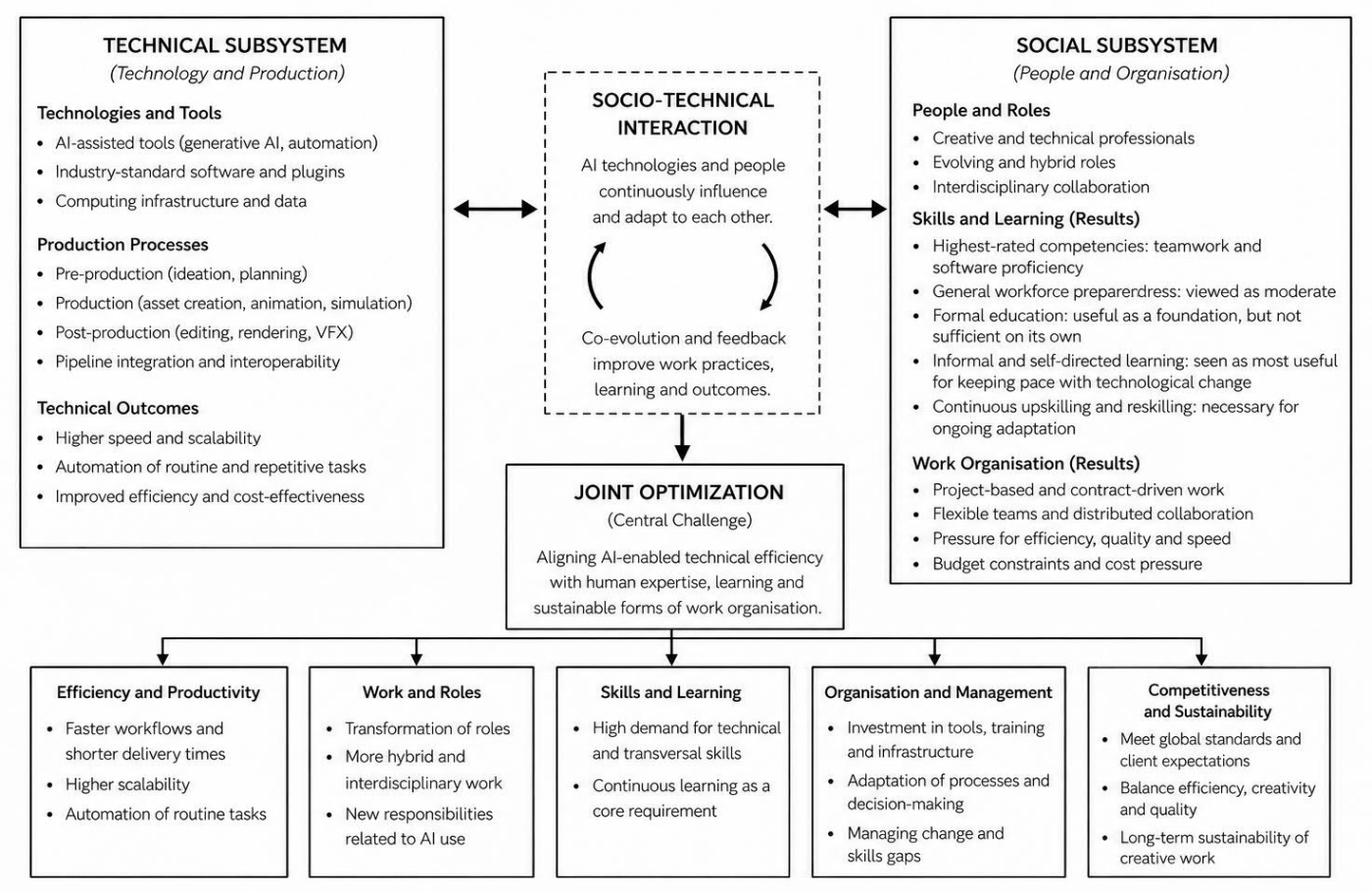



*Figure 1: Socio-Technical Interpretation of AI Integration in the Creative Digital Industries.*

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## Declaration on Generative AI

During the preparation of this work, the author used ChatGPT (OpenAI) for language editing and proofreading. Further, the author used ChatGPT (OpenAI) for Figure 1 in order to generate the conceptual visualization. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the publication's content.

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