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# INTELIGENCIA ARTIFICIAL EN LA GESTIÓN DE LA INNOVACIÓN

Tesis que para obtener el grado de

DOCTOR EN CIENCIAS DE LA INGENIERÍA

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DOCTORAL PROGRAM IN ENGINEERING SCIENCES

# ARTIFICIAL INTELLIGENCE INNOVATION MANAGEMENT

Thesis to obtain the degree of

DOCTOR IN ENGINEERING SCIENCES

Presents: Arturo Atl Rodríguez de la Torre.

Thesis Director: Dr. Gabriela Calvario Sánchez.

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To God, my family, friends, and all the people who supported me during this journey.

# Resumen

A lo largo de la historia, la humanidad ha experimentado varias revoluciones industriales disruptivas. Todas estas etapas se han caracterizado por su profundo impacto en la naturaleza de las actividades laborales, las discusiones éticas y la transformación socioeconómica. Durante las últimas cinco décadas, pero particularmente a comienzos del siglo XXI, un conjunto de innovaciones tecnológicas, la producción masiva y el uso de la información, así como un enorme aumento en las capacidades tecnológicas de procesamiento computacional, contribuyeron al renacimiento de la inteligencia artificial (IA) como un posible generador de una nueva revolución industrial. La inteligencia artificial se considera una tecnología capaz de imitar, reproducir y mejorar ciertas habilidades intelectuales humanas, convirtiéndose en una herramienta muy poderosa en innumerables actividades, pero también representando una amenaza potencial debido a todas las implicaciones éticas detrás de su implementación. Como resultado, numerosas empresas y organizaciones alrededor del mundo buscan entender y utilizar la IA para mantenerse competitivas en este nuevo campo tecnológico; por lo tanto, es necesario gestionar cuidadosamente la transición hacia la adopción de la IA. De esta manera la IA está entrando en el territorio de la gestión de la innovación y está experimentando una transformación fundamental. Como una tecnología emergente y en rápida expansión, la IA está interactuando con empresas y organizaciones, implementándose para interactuar y mejorar procesos y actividades de manera regular. La gestión de la innovación (GI) no es la excepción.

La IA muestra capacidades alentadoras y también muchos casos de aplicación que parecen susceptibles de ser explotados por las organizaciones para facilitar, acelerar y mejorar sus capacidades de GI. Sin embargo, la introducción de la IA no está exenta de desafíos y obstáculos; su inserción dentro de las organizaciones requiere un estudio y análisis cuidadosos. En consecuencia, este trabajo de investigación contiene un modelo de asistente de innovación basado en inteligencia artificial, que comprende elementos clave y centrales de la IA incorporándolos en los procesos estándar a nivel mundial de gestión de la innovación de empresas. Además, como derivación de este modelo, se presenta una metodología para la generación de propuestas de valor utilizando IA, siguiendo un proceso definido para demostrar un caso de uso susceptible de ser utilizado para potenciar a las organizaciones mediante el aprovechamiento de la IA en los modelos de negocio.

Finalmente, vislumbramos áreas tentativas de investigación futura donde se requiere un trabajo adicional para desarrollar una contribución más detallada a casos de uso específicos, así como un desarrollo más profundo y refinado de algoritmos que permitan pasar de descripciones adaptativas genéricas a enunciados matemáticos específicos.

# Summary

Throughout history, humankind has experienced several disruptive industrial revolutions. All of these stages have been notorious for their profound impact in the nature of labor activities, ethical discussions, and socioeconomic transformation. During the last five decades, but particularly at the beginning of the 21st century, a set of technological innovations, the massive production and use of information, as well as a huge increase in processing computation technological capabilities contributed to the rebirth of artificial intelligence (AI) as a potential generator of a new industrial revolution. Artificial intelligence is considered a technology capable of mimicking, reproducing, and enhancing certain intellectual human abilities, becoming a very powerful tool in countless activities, but also representing a potential threat for all the ethical implications behind its implementation. As a result, numerous companies and organizations around the world as seeking to understand and utilize AI to remain competitive in this new technological field, therefore a managed transitions towards the adoption of AI is in order. This is how AI is arriving to the dominion of innovation management and it is experiencing a fundamental transformation. As a new emerging and rapidly expanding technology, AI is interacting with companies and organizations, it is being implemented to interact and enhance processes and activities on a regular basis. Innovation management (IM) is not the exception. AI is showing promising capabilities and many use cases that seem to be susceptible to be exploited by organizations in order to facilitate, expedite and improve their

IM capabilities. However, the introduction of AI is not free of challenges and roadblocks, its insertion within the organizations requires careful study and analysis. Consequently, this research work contains an artificial intelligence innovation assistant model, that comprises key and core elements of AI that are incorporated into the standard innovation management processes of companies worldwide. Also, as a derivation of this model, an AI value proposition model is presented, following a defined methodology to demonstrate a use case that is susceptible to be utilized to empower organizations by leveraging AI.

The current research project is based on an exploratory and demonstrative investigation of the phenomenon of a new technology (artificial intelligence) that seems to be driving a new paradigm comprehension of innovation processes and practices. Due to the novelty of the topic, an initial and introductory glimpse on this new and emergent knowledge field is in order.

Finally, we glimpse tentative future research areas where further work is needed to develop a more detailed contribution to specific use cases, as well as a deeper and refined development of algorithms to allow the transition from generic adaptive descriptions to specific mathematical statements.

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## Introduction

Innovation management is a broad and seasoned knowledge area that has been studied, discussed and applied in countless organizations for decades, and yet, at least in the last lustrum, it has experienced the introduction of artificial intelligence as a potential pervasive and disruptive technology. In this research, we propose and demonstrate the application of a model as a vehicle to support innovation management to facilitate the understanding, integration, and adoption of AI into the regular and standard processes of organizations. More specifically, we display a methodological approach to innovate the stereotypical approach to mimic the execution of value propositions leveraging the capabilities of artificial intelligence. Ultimately, a renovation of the management process contributes to innovation in the whole organizational decision-making environment. Our findings shed light on the potential benefits that innovation managers and organizations may have to foster the inclusion of AI as a tool of innovation management assistance. Furthermore, we open a new path to conceptualize further areas of application where data processing and mathematical models may be exploited to facilitate the manual labor of technology innovators and managers. Artificial intelligence (AI) is not a new technology for the scientific community, decades ago the introduction and convergence of knowledge into several technical and technological applications and demonstrations set the stage for the exhibition of AI as a new and pervasive technological paradigm, reaching countless industrial fields and presenting enhancements proposals for all sorts of businesses and firms. Strategically and operationally the impacts are being observed with utmost surprise due to the speed and the urgency to adopt and adapt tools such machine learning, generative content, fuzzy logic among many others. There is not a general and universal agreement of what AI means, a simple conceptualization could be "a knowledge field that seeks to mimic and enhance intellectual human capacities". However, this definition sheds light on the current constrains of AI, up to what extend can the combination of computational power, data fetching and processing and mathematical modeling-applications compete with human intelligence? Looking back at previous and similar questions, we can see nowadays that a high precision printer is practically unbeatable if we were to compare a human artist performing a realistic picture, but here raises a new question, is this printer really replicating accurately a depiction of reality? Or is it merely reproducing a set of data in an extremely precise way without having the slightest hint of what reality is? Id est, a task driven device which simulates a picture of reality but it has no means of replication but what was set up for in the first place, in this case can we call intelligent an extremely sophisticated technical resolution of a task but which is limited to the boundaries that were initially implanted for its functioning? These questions extend beyond the scope of the present work, but they do open the discussion to question what AI really is, where it is heading, and most importantly what are the real impacts we can expect in the near future.

Artificial intelligence (AI) is being positioned as a basic underlying technology for a countless number of applications, it is said to ignite a paradigm change and a new industrial era, and as such it becomes relevant to study the effect and impact it has on technological management practices and processes. Firms and organizations have a growing interest to explore and exploit the benefits of many digital emerging technologies, artificial intelligence is not the exception. However, organizations may not have or know the required capabilities to implement AI into their innovation management (IM) processes. At least, a set of basic skills and knowledge is necessary to carry out a promising adoption of AI tools. Additionally, even directors, managers and strategists often lack the elemental knowledge to figure out where to start an AI adoption and what are some of the potential benefits and use cases. AI is also becoming a competitive advantage, and it is now part of the fundamental innovation management infrastructure.

The innovation management processes are a living mechanism and as such, AI is certainly evolving the way to innovate. A methodological research approach serves to facilitate the incorporation of AI and specifically machine learning techniques intro the realm of innovation management. That encompasses several and simple use cases and tools where companies and even SMEs can leverage and implement AI to improve their overall innovation performance.

The aim of AI within innovation management is not -at least for now- to provide a multipurpose or general path to tackle all the challenges and requirements of a functional AI innovation manager but to unravel a series of techniques where companies and users can get benefits from these state-of-the-art AI functionalities.

The Literature review and technological context that we present sits on top of an evolving VUCA (volatile, uncertain, complex, and ambiguous) environment of innovation management technology and engineering, under these conditions a relentless search of new publications and findings is in order,however, the current investigation includes, as part of its findings, results, and conclusions,state of the art research for the present time.

## Method, Materials, and Epistemological Approach

The current research project does not have scientific positivism as the sole means to access verifiable knowledge,and yet it employs its methods, propositions, and considerations to achieve fruitful results and conclusions derived directly from experimentation and validation. A priori and a posteriori evidence is presented as key aspects in assessing the value of research products. We seek to replicate an experimental laboratory analysis using evidence. Nevertheless, critical realism, hermeneutical considerations, pragmatic heuristics, and qualitative methods, as well as social constructivism for industrial purposes or applications, remain essential knowledge means for the whole understanding of this research's methodological approach for innovation engineering sciences. In brief, the validation methodology was composed by the following elements: a use case simulation, particularly for words' classification. A patent publication request, used as a prospective validation in which it takes place as a coadjutant revision of experts. It can also be understood as techno-vigilance analysis to consolidate and present some of the latest findings and insights that support the investigation.

The methodological cognitive core to formulate the research products of the investigation is based on deductive and inductive diachronic phenomena of the innovation management practices observed and pondered in industrial, academic, and marketing environments. The composition of the model includes a descriptive analysis of its parts, stages, and connections, as well as a scientific discussion of dialectical analysis, which is included in the discussion of results section. Therefore, the research products are not merely the graphical representation of its components per se, but the knowledge -episteme- within them. Although the graphical representation may vary for organizational implementation purposes that are not yet tested-doxa-, the present work elaborates the following rationale:

The unpredictability of organizational behavior makes the empirical evaluation of innovation management models a unique experiment whose replications on different organizations cannot guaranty results; although implementation execution may derive lessons learned and knowledge that have the potential to assist other organizations that may have similar conditions, it cannot fully provide an evaluation of a wide range of systemic conditions that embrace and characterize a particular set of companies under a similar profile, i.e., systemic models have a scope that circumscribe the main characteristics (culture, digitization level, size, etc) of the archetype of organization that they seek to represent. As a consequence, an alternative path of validation is proposed in section F of this methodology.

The following structure defines the framework used for the overall research project, and a particular methodology is described for the construction, validation, and experimentation of the research products. The innovation management model and the research products presented in the document employed the scientific method to validate its findings and limitations. The specific steps employed in this method are enunciated in the following general steps:

A) Observation phenomena.

B) Problem or situation statement.

C) Conception of a set of hypotheses.

D) Review of theoretical and state of the art knowledge.

E) Solution proposal and methodology

F)Validation and experimentation

G)Analysis of results

H)Conclusions

The composition of the model is not meant to represent an all purpose design but a facilitation platform for innovators to engage AI into their processes environment. To achieve this, we display the following methodology:

E1) Identification and selection of traditional or legacy close innovation management models.

Based on the theoretical framework and the literature review, we select a stereotypical innovation pipeline based on the following criteria:

E1.1) Adoption

The archetype most widely used and adopted for a close innovation management model. Based on a review of the literature and theoretical framework, an archetypic close innovation management model is selected. Containing the core stages of its process and phases. The model presented at this stage is nothing more than an archetype presented graphically as a waterfall prototype.

E1.2) Simplicity and scalability

We recognize the minimal stages and process gates inserted across most of the models employed and applied in industry and academy. Based on the literature review analysis, we establish an initial footprint of stages as part of our hypothetical solution, which is eventually validated and discussed.

E.3) Flexibility

Innovation, creativity, and project managers are meant to implement the proposed model; this requires expertise and labor due to the intrinsic customization required for the implementation of processes in organizations. The selected model is meant to be adaptable; to assess such characteristic, the selected archetype is shaped in generic stages that, in spite of their generalization, remain representative of a standard innovation pipeline stages. In other words, the stages must be (simultaneously) generic but not ambiguous.

E.4) Universality

Although there is no multipurpose and all-encompassing model (one size fits all). We select the features of a model that embraces and typifies the most common or repeated practices performed by innovation managers to approximate a characterization of the current processes that organizations have. Unlike adoption, this aspect highlights the theoretical conception of a process and not the actual performance or execution of processes.

F) Validation or experimentation

To apply the epistemological approach employing specific research tools from the following main sources:

F.1) Literature review, including theoretical and conceptual frameworks.

F.2) A set of use cases description.

F.3) The implementation of a particular use case analysis employing text mining and machine learning techniques.

F.4) A set of key performance indicators(KPIS) designed to evaluate innovation technology management.

G) Analysis of results

H) Conclusions

## Observation of phenomena and Problem

At the beginning of the second decade of XXI century and nowadays, a rapidly growing interest in artificial intelligence as a disruptive and pervasive technology is modifying the habits and techniques to address technological endeavors in countless industrial and engineering areas; i.e., a new state of the art and state of the technique seems to be quickly penetrating.

Numerous firms and organizations, particularly, small and medium enterprises, seek to integrate artificial intelligence into their ad-hoc innovation processes; however, they struggle to find a baseline to encompass and manage key and core state of the art technologies with management processes to unlock innovation; as a consequence, these organizations' survival and their competitive advantages are being questioned and jeopardized because of the uncertainty of the efficiency and value demonstration of artificial intelligence as a key technological player in their creative and innovative environments.

## Research questions

1) What kind of role and scope will AI have as part of innovation management processes?

2) What features and outcomes should a minimal innovation management pipeline-system have in order to facilitate the adoption of artificial intelligence tools?

3) How can an innovation management system incorporate artificial intelligence into a stereotypical close innovation model?

4) How can we diminish the complexity to frame innovation management processes with the relentless pace, ripening and ontogenesis of artificial intelligence assistance to keep a flexible environment for innovators?

## General objective and Scope

To identify, evidence and display the fundamental role that AI will have for the innovation management process to be able to demonstrate whether AI will become an actual and essential player disrupting and reshaping the paradigm of standard innovation practices.

## Specific Objectives

1) To develop an innovation management system that encompasses and embraces the introduction of artificial intelligence techniques with the most commonly employed practices and processes of innovation management technology, seeking to aid and ease the adoption of innovators through the engagement of AI.

2) Explore whether innovation management processes will shift due to the introduction of AI that changes its archetypic ontology.

## Hypothesis

Artificial intelligence assistance shifts the way innovation management processes are handled, by introducing alternative practices to manage data and information to articulate and support value propositions, use cases, and content for businesses and firms. Its inclusion requires a new conception of innovation and systematic coordination in organizations that wish to include such tools to facilitate tasks and activities. This technology requires a robust effort of process customization and it is currently limited to human assistance not replacement, but it is becoming a key technology for strategical competitive advantage.

# 1. Literature Review

A Brief Outlook on the Evolution of Technology Eras and their Impact.

What is technology? This basic question underlies a simple reality; humans have always used tools, artifacts, or any sort of item to assist in their labors and intentions. In simple and general words, technology comprises every form of facilitation methods and tools we employ to achieve our goals, desires, or objectives; frequently dominating, prosecuting or manipulating nature in one way or another in order to control and manage the conditions of an experiment or an endeavor to attain defined results. From primitive constructions of households as means of protection for the weather or animal attacks to efforts to explore the cosmos to better understand the universe and our place in it. Therefore, we may think of technology also as a submissive arrangement of materials and knowledge to create and operate means of assistance and support. So, technology has a long history and shows our capacity to interact with the world from a deliberate perspective. Technology also represents and serves a way to reflect our relationship and understanding with nature.

Throughout history, we have learned and improved our methods to develop technology, and we have also seen the impacts of technology in all aspects of human life and the planet as a closely interconnected ecosystem. The need for constant and relentless improvement has brought up the concept of innovation as a way to create and implement new means (whether technological or not) to progress and enhance human conditions[1], [2]. Furthermore, when these techniques are carefully studied and crafted we have called them: engineered sciences, because they follow a defined and rigorous methodology that has proven to work under controlled conditions. As a result, we can oversimplify the process of technology in history in a few steps: 1)need or pain detection 2) research and development of a new solution(product, process, method etc.) 3)implementation of the solution 4) feedback and learning. As we learn we are supposed to revamp our technology to obtain better results. This process of improvement and search of innovation can be considered as a driving force for technological evolution [2] Here lies a watershed question, how do we understand and evaluate what "better" is ? and what does "better" actually mean?

Historically and generally, a human-centered comprehension of technology has shaped machines, products, and services, relegating systemic and environmental impacts, considering side effects to be mild and bearable, i.e., the cost-benefit relation is acceptable according to our values and estimations. Nevertheless, a non-human self-centered philosophy of technology exhibits many catastrophic scenarios for all shapes of life in the planet, and as a consequence, impacting human life as well[3][4]. How come technology deviated from assistant to treat? how come technology became part of the problem and not the solution to achieve well being? An overall and quick look at technological history can give insights to approach these questions.

A holistic view of technology history can be summarized in these major eras: 1) Ancient world, 2) Middle ages and renaissance 3) Industrial revolution, 4) Information and digitization revolution 5) Cyber-physical revolution. Undoubtedly, the definition and classification of these eras is widely debatable, and yet evidence [5] [6] shows a general agreement on their characteristics and frontiers. In FIG 1 we can see a classification of stages, a general division of four industrial revolutions.

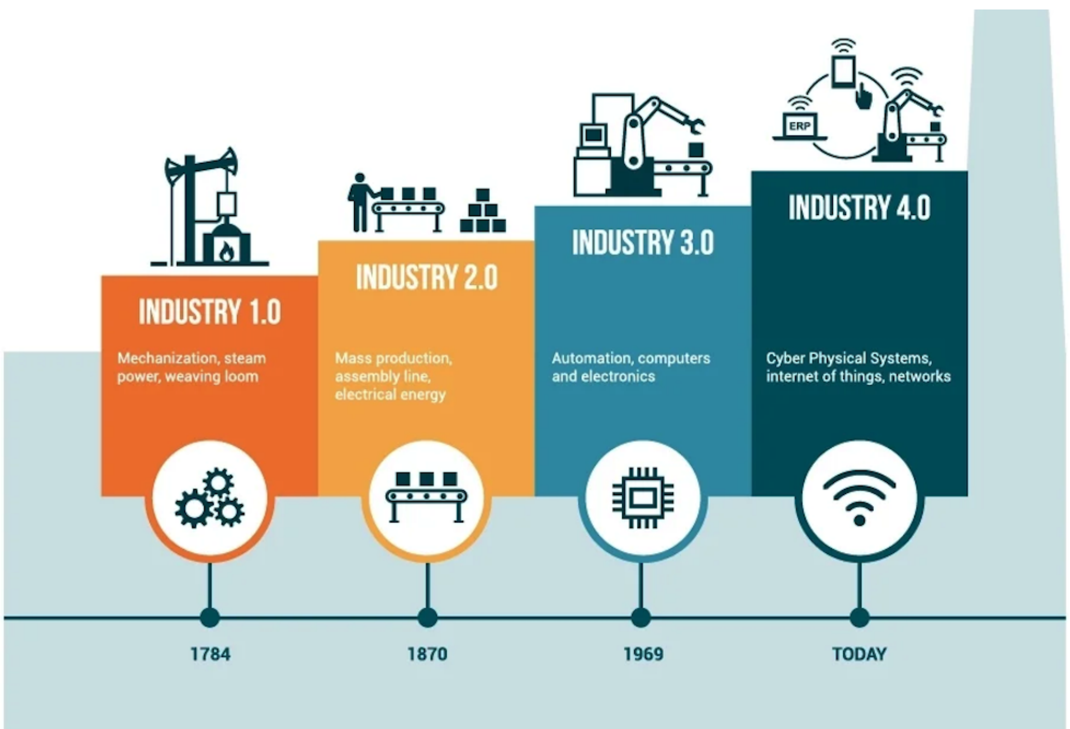


**Figure 1:** Industrial revolution stages.Taken from: [6]

There is extensive literature on characteristics and particularities of these eras. We can focus on one aspect in particular, the "intimate connection between virtual systems and physical systems, the cyber-physical revolution which includes AI, involves and transcends the previous technologies, i.e., all new technologies seek to incorporate the latest available knowledge to present "avant-garde" knowledge, which is ultimately embodied into innovative products and services. The evolution of these products and services largely due to a never ending effort of research and development, has provided society with enormous advances of in fields such as healthcare, telecommunications, etc. All these benefits have been deeply incorporated into the culture and habits of people. Nowadays it is impossible to conceive humanity without all the cyber-reality created around him.Let's take for instance all the information systems that cooperate in a daily basis in practically all types of jobs, including, computers, internet services, satellites, videoconferences, just to mention some examples. Naturally, this technological progress has also created a symbiotic relationship between human life and technology, this relationship has given birth to the coexistence of a new industrial era, industry 4.0. revolutions.

## 1.1 The Escalation of Technology

Today, the interaction between human-beings and machines is embedded in every single aspect of life. From express preparation of food to social networks communication, from millions of automobiles that are ignited every day across the globe to medical images that are interpreted by physicians to diagnose a disease. In general, all our current tasks and endeavors include some kind of technology. The impact, whether a benefit or a repercussion of the incorporation of technology is now a household topic, due to the undeniable environmental disturb that many technologies have had. This is why in the last decades the introduction of topics such as systems thinking, circular economy models, recycling, etcetera; have gotten great attention from scientists and environmentalists[3][4][7], even religious leaders took steps to speak up on this matter[8], not to mention the impulse from economic interests that boosted technological progress in order to thrive in extremely competitive markets.

The supremacy of technology also entails careful considerations and risks; for instance, in Figure 2, a global venture builder and online incubator company displays five risks tied to technocratization. These risks are only a summary of the impacts that a neglected and disproportionate use of technology may have in society if a revised and studied implementation of technology is not adequately exercised.

For all those companies clearly rooted in the technological world, innovation became an imperative field. The relentless need to demonstrate value brought fantastic and unthinkable achievements, but it also carried huge collateral effects. In other words, technology, even from its very beginning and today, has been a vehicle to obtain advantage and power; today this statement is still true[9]. The manipulation of natural resources to turn them into artifacts for a pre-designed and specific functioning has a very long history; the wheel, the discovery of agricultural techniques and the invention of the printing press are only some examples of disruptive technologies that changed the world.

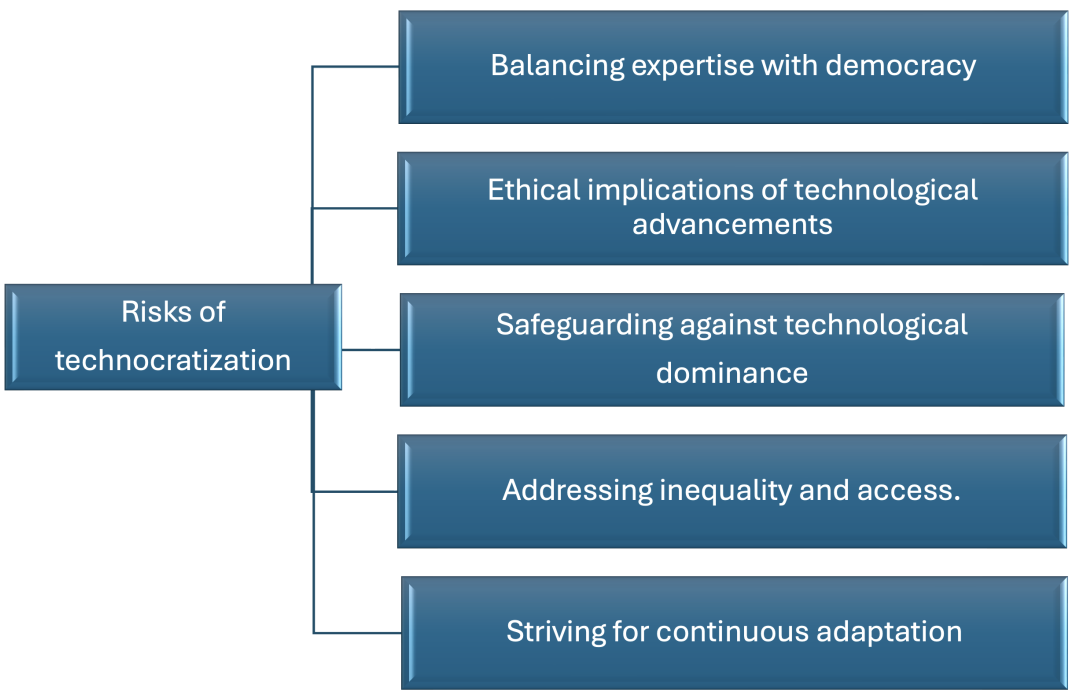


**Figure 2:** New technocracy. Taken from: [10]

In other fields such as biomedical research, countless publications aim to develop nano-machines and robotic assisted surgeries to boost the efficiency of medical procedures. So, the interactions between cyber-systems and humans are increasing, unlike the stereotypical conception that depicts a cyberhuman as a robotic-body human, we may be becoming cyber-human with cyber-minds, i.e. we operate most of our activities with an artificial and external connection to develop any labor. We may not be replacing our internal organs with robotic implants (or at least not yet) but we are certainly replacing many intellectual capacities with artificial devices such as writing and reading.

The 20th century created an explosion of technological developments that had no precedents. No other period in human history had seen the delivery and production of technological progress as this period did. Beyond the political and historical background of this huge expansion, human population also increased at an unprecedented rate during the 20th century, from around 1.5 to 6 billion, just within this time span[11].

With the addition of global markets and international commerce as well as all sorts of new technologies that demand electricity or some form of energy as fuel, a huge increase in natural resources consumption became a major global concern, not to mention the side effects of pollution on human health and natural ecosystems.In addition, during this century, the human race - through technology- learned to develop massive destruction weaponry such as nuclear bombs; allowing to obliterate extensive areas and cities within seconds and turning them into wastelands, along with the long-term destructive effects of radiation. Moreover, the expansion and creation of new and sophisticated military equipment augmented dramatically reaching a 2.7 trillion USD in global expense in 2024. That's approximately 10% the amount of USA gross domestic product(GDP) in 2024[12], that's about 2.5% of world's GDP. In general, technology innovation became an extremely important asset for countries serving all kinds of purposes (military among them) becoming one of the highest priorities for governments around the world.

Indeed, technology's role in human life became indispensable to sustain social demands. In this context, as a result of a deeply interconnected world, the power of super computers and the availability of mathematical and engineering methods opened up new possibilities to produce models that could mimic certain human activities, giving birth to a whole new explosion of informational capabilities to be exploited once more by the industrial and social demands.

## 1.2 The Introduction and Explosion of AI

In conjunction with felicitous circumstances, the introduction of computer systems, data engineering and interconnected networking environments in new fields of businesses such as automobile, banking, healthcare,social networking, telecommunications etc. prompted a new age of artificial intelligence, a technology that had been theorized and researched decades ago[13] seemed to have found now fertile land to grow as a new engineering branch with expanded capacities and promises. In order to maximize businesses and economies, AI has been pushing researches, engineers, investors, CEOs and leaders around the world to look at it as a disruptive technological differentiator capable to ignite a new industrial revolution[14][15]. A deep dive into AI's current momentum shows that massification of smartphones, social networks, IoT, and many other electronic devices, created sources of data that propped models to be fed with enough inputs to display accurate and functional algorithms to replace human functions[16].

The inclusion of AI assistance tools to offer facilitation development of tasks is escalating extremely quickly, especially in all those digital services and platforms that have access to manipulate and use data to create use cases such as: profiling to improve users' experiences, forecasting parameters, expediting manual labor etc. For instance, see all the diverse applications that are addressed in [17]. The accessibility of data and the computational power to engineer models paved the way to transform use cases into business cases, companies that had invested in data collection technology are now seeking

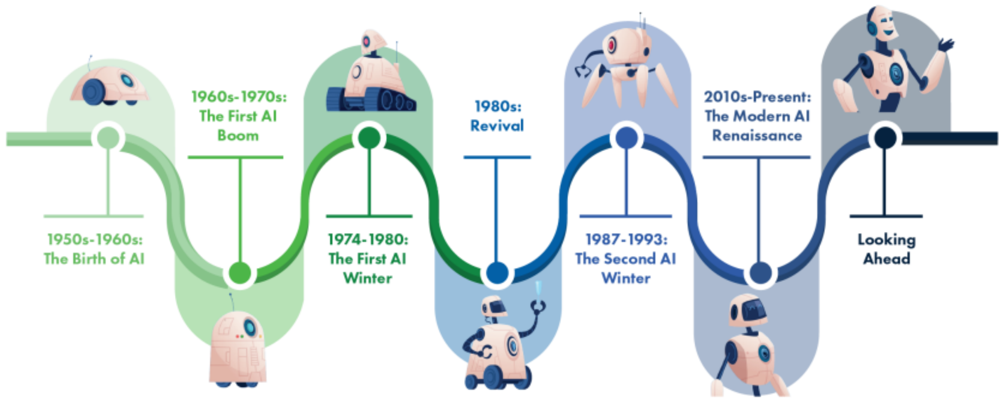


**Figure 3:** AI evolution. Source: taken from: [19]

to use and harvest benefits and advantages[18] . Moreover, a countless number of products and services are now susceptible to be interconnected with a digital platform and a database, as a consequence, there are extensive research areas where AI can help to innovate. As an example, we can think of a car, perhaps one of the most iconic products for the 20th century in terms of growth, utilization, environmental impact, people's habits transformation and technological development as a vehicle for transportation. This product has now become a mobile computer not only a automotor vehicle.

Nowadays, basically all cars' manufacturers include a computer into the vehicle as an essential component to control and manage the car's functions.The car is integrated with cables, sensors, and displays to have an interaction with the user and the environment, not to mention the latest automated vehicles that offer an autonomous drive. This level of system's integration reconfigure the understanding of products and services, in other words, such level of alterations re-conceptualize the meaning of products, which ultimately means, a clear innovation in products' technology. Similar stories can be told for many other products, there would be an endless list of examples where AI is pushing a semantical and technological reconception of products and services, therefore promoting an innovation spillover effect and fostering products' diversity and heterogeneity[20], this spillover effect is quite relevant for companies that are aiming to sustain an ongoing and relentless innovation drive as part of their strategical competitive advantages.

Al is conceiving a new paradigm for innovation management, it is innovating the way we do innovation[21], [22], [23], [24]. This affirmation states that common practices and techniques to innovate are being modified due to the introduction and utilization of AI, i.e., state of the art of innovation management. Naturally, innovation management practices will take time to assimilate up to what extend AI is able to contribute or replace activities that used be performed by humans; nevertheless, literature and companies' strategical objectives are aiming to integrate AI as a regular tool for their innovation processes. This means, AI is being enabled to play as an assistant to facilitate innovation processes[22]. This facilitation exercise assumes an ability to outperform human at certain activities that enhance the holistic attempt of innovation, but it does not necessarily reforms the concept and understanding of innovation, to achieve this titanic challenge, an AI system would have to prove its ability to be creative and most importantly its capacity to mimic originality. In figure 4 we can see a depiction of the current use of AI to serve as an originator or a facilitator, depending on the situation and context of an organization and the maturity level and flexibility of their products and services to be shaped and modify without major repercussions.

This figure calls out an important aspect in terms of organizational flexibility, for emerging companies it may be much easier and more useful to implement AI as an originator, where AI plays an important role to kick off the innovation processes, while for mature and established organizations, AI may play much more as a facilitator, augmenting and enhancing products' capabilities. But, what do creative and original mean? During creative processes, how do we assess and value what creativity and originality are? Here, we can see that, in addition to engineering, mathematics, and data, AI steps into the dominion of human sciences and art[25]. After all, intelligence is a term that has been closely linked to be an almost exclusively human capacity; evidently, attempting to replicate this capacity requires a serious understanding of humanity, and as such, it also exposes the necessity to examine the systemic and social implications of creating artifacts of virtual intelligence to be inserted into our world.

The ethical,moral and social considerations of AI are entitled to have a whole field of research, consequently we can see that a deep reflection on the implications of AI's implementation is in order, especially in delicate scenarios where there can be philosophical dilemmas. If we start from the point and assumption that AI is indeed capable (up to a certain degree) to replace human creative and intellectual capabilities, it is indispensable to present a

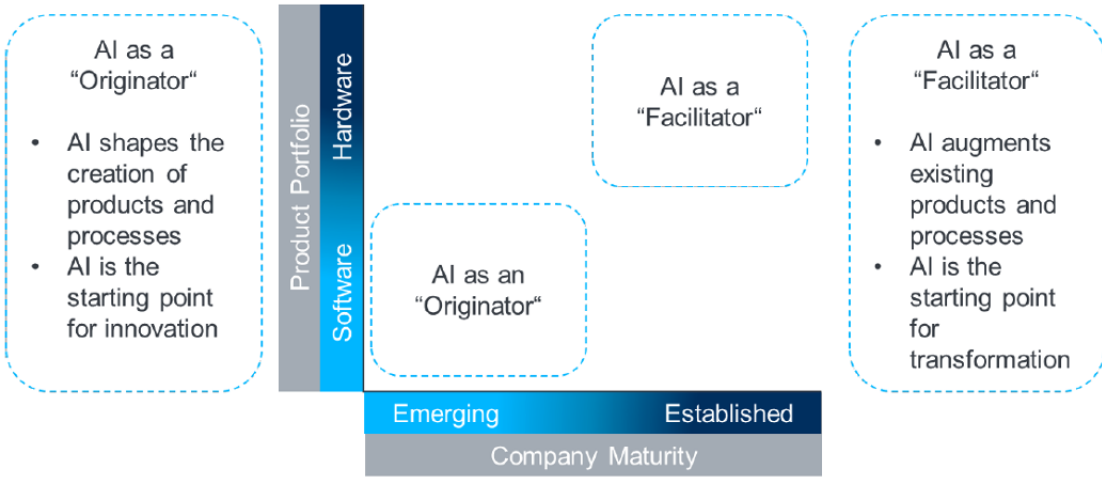


**Figure 4:** AI as originator and facilitator. Taken from: [26]

regulatory framework to operate[27]. These efforts are in motion in places such as: Europe and Japan[28].

Clearly, if we aim to replace a human activity and use a machine, we need to explore the implications of the substitution beyond the engineering frontier. Otherwise, we're taking the risk to forget that ultimately technology is supposed to improve human life, and as such, innovating technology just for the mere fact of enhancing it may become counterproductive. In other words, the technical improvement of a given innovation does not grant it the title to be innocuous.

There are already discussions taking place due to conflictive use cases where AI's introduction has been questioned, a few examples are: Automation bias leading to discrimination, racism, classism, etc., moral responsibility vacuum, informational privacy breach, decision making opacity, among many others[29].

If we look at the representation model of the epistemic process of AI life cycle depicted in figure 5 from the problem domain to a given AI model, we can gaze at the steps in the depiction to see that we must generate information and knowledge from our initial data gathering, this epistemic process is decisive for practically all purposes of any AI solution implementation; thus, if the knowledge generated from the data is somehow biased, mistaken, corrupted, or simply wrong, the ramifications of these errors will spread throughout all the AI system. Therefore, the evaluation and testing of this knowledge becomes imperative, and it also reflects that at a fundamental level, AI is still in need of human supervision, and although it may be able to tackle and outperform some human activities, it does require a monitoring and validation stage.

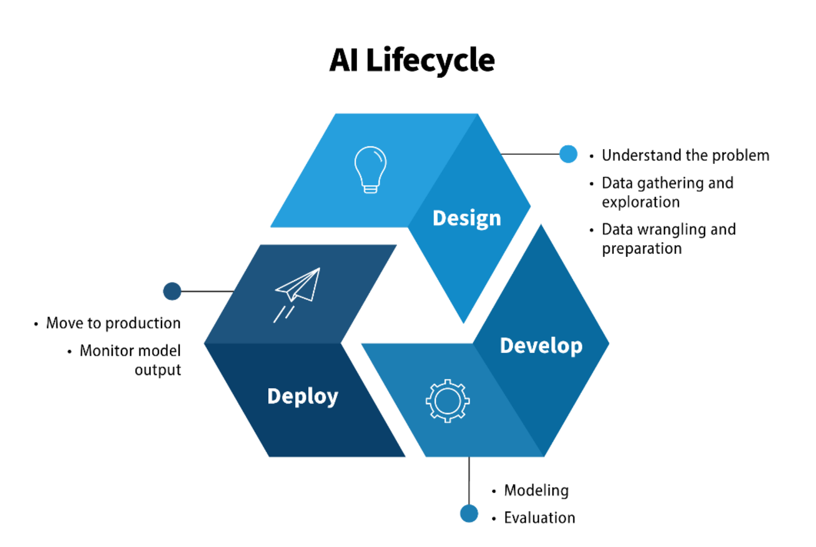


**Figure 5:** AI lifecycle. Taken from: [30]

## 1.3 Innovation Management meets Artificial Intelligence

Innovation as a Key Technology Driver

In history, knowledge becomes the accession, discussion, refinement, and evolvement of a human endeavor learning to address questions and situations that are deemed to be relevant for our purposes and desires. This ongoing endeavor often meets turning points that can unfold into an industrial-technological revolution or a whole new conception of a scientific paradigm. These points are usually characterized by a few repetitive factors, some of them are: 1) Technology breakthroughs 2) Deep industrial or potential macroeconomic impacts 3) Extensive and wide range of products and services are affected 4) Social, political and ethical side effects 5) Cascaded new scientific findings and proposals. These factors, along with many others, set the stage for the inclusion and establishment of a historic turning point in technology[31], [32]. As a result, the configuration and focus of organizations towards AI changes; it is not only another new technology, but a new conception of developing technology, i.e. AI sets a new environment to innovate and to manage innovation; furthermore, it disrupts the stereotypical innovation processes by introducing alternative ways to shape creativity, ideas generation, information analysis, profiling evaluation, and many more.

During the last decades, technology innovation became increasingly important for companies to thrive in a competitive environment, in order to make continuous progress in products and services, research and development (R&D) was set as the basis for innovation and subsequently innovation as one of the pillars for commercial and strategy success [33], [34]. However, despite the widely used term of "innovation", there is not a general consensus of what innovation really is, even when we are able to track and identify similar conceptions, a widely accepted definition is still debatable. The definition and scope of innovation has been an ongoing discussion for many years; in this document, we leverage the following concept: “Innovation = Invention + commercialization/implementation” [35]. One of the core aspects of the discussion relies on the understanding of this concept. From one side, many organizations deem innovation as the mere production of an idea or an "Eureka" moment that untangles a particular riddle, and similarly scientists and engineers tend to confuse invention with innovation[35]. From another side, innovation is seen as the fulfillment of value delivery and adoption of a new product, service, or organizational and human arrangements such as new processes engineering. This latest conception of innovation widens the scope of its understanding and links innovation engineering sciences with many other knowledge fields such as social sciences, psychology, marketing, etcetera. This is also corroborated by looking at the definition proposed in: "Innovation and the understanding of proccess of innovation is fundamentally about social, scientific, and economic change. Innovation is seen as underpinning the productivity and success of firms, communities, and nations.

Innovation, as a concept, is increasingly considered as a nonlinear multidimensional phenomenon, which involves a complex relational ecosystem with concurrent processes of value cocreation through collaboration. Innovation can be understood on several broad dimensions – product or process; technological or non-technological; radical or incremental; and open or closed" [36], this speaks of the vast and pervasive grasp of innovation in terms of technical knowledge domains.

Along with this concept, innovation management sits on top of this discussion, due to the necessity and complexity of innovation, innovation management steps in to serve as a set of tools and processes that promote the ability to develop, implement and adopt innovative products and services, social proposal, to develop a sustainable value proposition. To add on this, AI is also being presented as a new potential new component that may be able to re-signify the understanding of innovation. AI is also a whole field of knowledge which is usually placed under the scope of computational sciences. AI encompasses several technological branches, and although there is not a general consensus of which these branches are either, we can call out some of the most widely accepted: 1) Machine learning, 2) Natural language processing 3) Expert Systems and 4) Robotics[37].

AI can reach and influence technology development and even areas that could seem to be "peripherals" when they are not, such as finance and sports management[38]. But this never-ending search for innovation does not stand alone; besides the numerous and fruitful benefits of innovation, there are several direct and indirect impacts that must be faced, the introduction of new products, services, business models or any other conception of technological

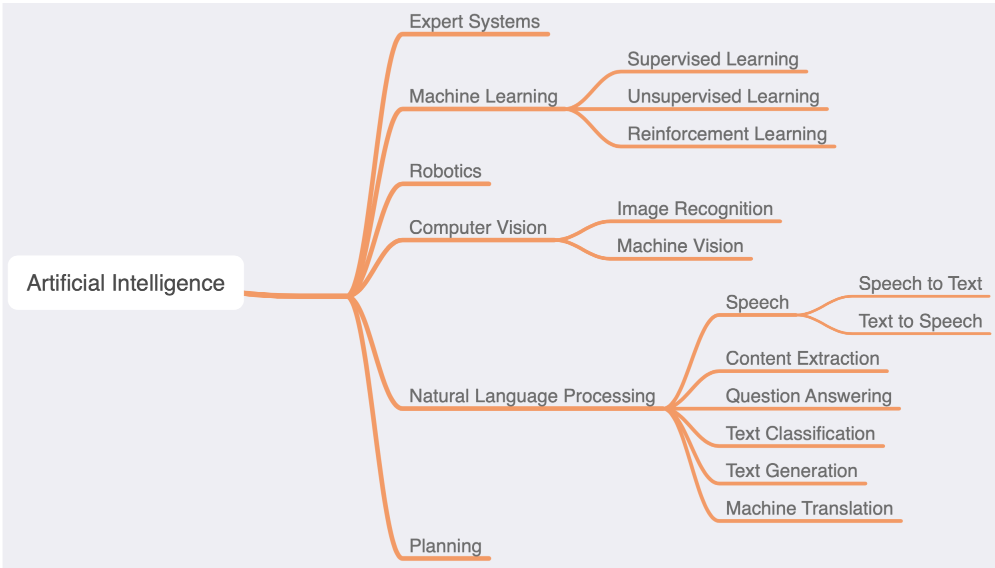


**Figure 6:** AI branches. Taken from: [37]

innovation- requires to be managed. Innovation, and particularly disruptive innovation, can have a widespread systemic effect on the whole world. For instance, the combustion motor, at least in the last one hundred years, has had a repercussion in basically all aspects of human and non-human life. As part of AI, we can find several branches, machine learning(ML) is one of them, within ML lies deep learning, as it can be seen in Figure 6.

Technology is not necessarily innocuous, it requires to be managed. This is also true for the sake of organizations, companies, firms, and businesses; the management of their technology plays a vital role to the success of the company; whether they use it for production, selection, delivery or any other role, in one way or another all industries require technology and some of them even use it to create new technology, the latter requires even more attention to management processes since emerging technology poses many unknown risks and critical factors. This is one of the many disruptions that AI is bring-

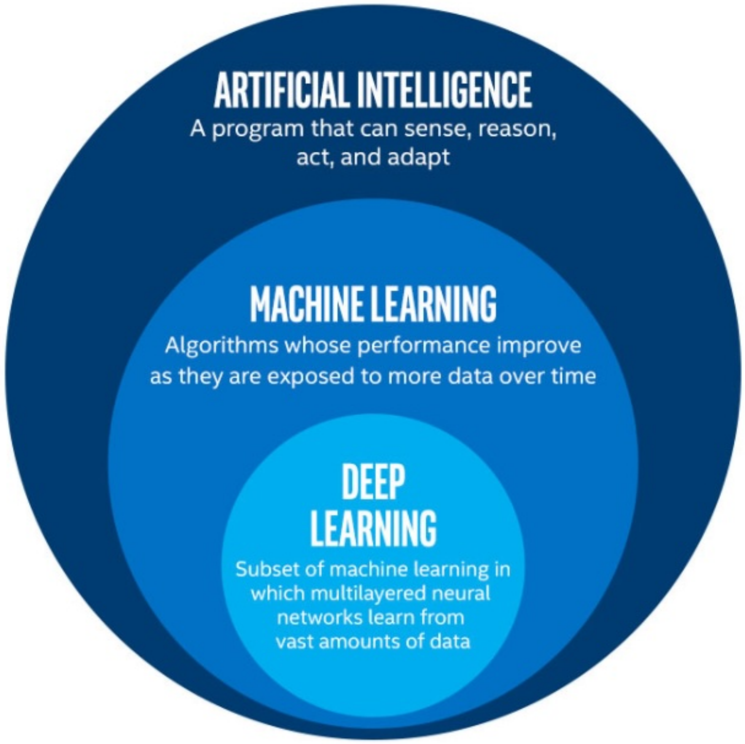


**Figure 7:** AI subareas. Source: taken from [39]

ing, this technology is being incorporated into regular operational activities, from paperwork review enhancements to medical imaging analysis, as well as strategical managerial analysis[17].

AI is becoming an essential tool to support different aspects of an innovation management system within an organization **Nina**. But, what does artificial intelligence mean? There's no a widely accepted framed definition of AI, a simple description is: «artificial intelligence is a composition of knowledge and technology that seeks to imitate and reproduce human intellectual abilities». It is therefore a neural center and the juncture of several scientific domains, including the technological and human sides.Furthermore, it comes up the necessity to understand the concept of intelligence and whether AI is really "intelligent" or not. In [40], [41], for example, the understanding of AI is studied and scrutinized, and the idea of AI as a real intelligent being is questioned and criticized.

Intelligence is a deeply explored and debated concept,nevertheless, it seems clear to consider it as «the capacity to apply knowledge and skills to solve problems and address needs», here is precisely; where the controversy starts; AI by itself is not able to apply any sort of knowledge or learning, it cannot operate independently; and it does not have any sort of standalone reasoning. Moreover, AI, at least at the current state of the art cannot display any sort of conscience, i.e. the capacity to be "aware and mindful" of its own existence and the ability to describe itself as a self-being.

What can be understood as an AI? An AI could be view as a partial, limited, scoped, or delimited reproduction or imitation of "a set of intellectual" human capacities, where not - or not necessarily- all the abilities of the human-psyche are incorporated into the artificial intellectual components that are being replicated. Integrating all these components would mean an unthinkable breakthrough, this is closer to the conception of General Artificial Intelligence (GAI), a futuristic and theoretical AI capable of learning and performing any human intellectual ability [42]. In this instance, we can distinguish the purpose, scope and limitations of an AI versus a GAI, the limited scope and the specific task-oriented design of many AI development grants them a distinction to emulate a set of human intellectual abilities without reaching the full depth of more complex endeavors.

Nowadays, there are numberless examples of machines executing games, tasks and labors where they have proven to beat human capacity, or at least, to match it[43]; chess games, voice and face recognition, texts development, etc. All these contributions lead to an organic consequence, research and development, products and services creation and innovations are meeting a new way to execute and carry out their job cite. As a consequence, the practices and ways to integrate this technological progress into our context require a new understanding of innovation management(IM).This new understanding embraces AI as a partner[44], or a cooperator, it can also be understood as a new master-slave dynamic, where AI serves the purposes of the requester. This dynamic modifies the procedural approach towards IM, and it also depicts new scenarios where IM will need to interact with AI in a regular basis. Therefore, AI is presented as a facilitator and a platform to ignite IM processes if felicitous conditions exist.

Management of technological innovation includes creativity as an additional element that is intended to broaden the inherent value of innovation, the utilization of AI as a creativity tool is being explored and employed already[45]. Creativity is also a widely discussed concept, what is creativity and up to what extent can we consider AI to be able to reproduce or simulate it? In simple and broad words, creativity is the act of producing or originating a unique being; usually, an artistic work, an unprecedented invention, or even a breakthrough idea are examples of creative insights and intellectual contributions. Underpinning AI as a creative tool would entail to demonstrate its originative potentialities, these potentialities are now available in multiple products and services such as generative AI content creators and chat-bots that interact with users to render ideas, sketches, etc. The mere reproduction and creation of these contents represents a great achievement. Nevertheless, if we inspect the roots of some of these tools in terms of functioning to perform creativity, do they still hold the test to be called intelligent? Furthermore, can they be called creative if the parameters and the underlying mechanisms of their functioning hinge on mathematical-computational modelings? Id est, is the machine not simply simulating intelligence and creativity based on a predefined set of human instructions (however complex these can be)? At a fundamental level, the answer seems to be clear, indeed, the machine itself, at least at the current state of the art, is not intelligent or creative since it does not possess the ability to rationally and purposefully operate and interpret itself or any given task at hand[46]. This is why it turns out to be imperative to include the "artificial" factor within all this description.

An artifice is possible and even acceptable because the results, behavior, and functioning may appear to be intelligent by making a "trick" to behave in a human-like fashion and therefore achieving the goal to impersonate a human-like performance[46]. As a consequence, artificial intelligence conveys the idea of a simulation, and as such, it allows to set boundaries and a delimited scope to the implied functionality.

Gathering all these concepts and definitions, it is possible to gaze how the innovation management practices are starting to cooperate with AI to produce technology, and also, how AI will cooperate with pre-existing technologies to produce innovation. We can picture AI as a new team player within organizations, where it has a specific role meant to facilitate and boost the processes, activities, and tasks related to the sought objectives.

AI is formed by three knowledge domain areas: 1) Mathematics, at the root of AI models and algorithms lies the mathematical foundation of its functioning which becomes valuable for all sorts of applications due to the second element 2) data, while the mathematics provide the structure and scaffolding, data are the raw material for the information processing, i.e. without data there would not be the necessary inputs to obtain meaningful and valuable information, moreover, the data feed models, algorithms and systems the behavioral expressions of any phenomenon that we are exploring or studying. As a consequence,the comprehension or approximation of a all phenomena we perceive can be exercised by means of the data that we are able to perceive, and ultimately to process(within our body and brain), similarly, the training and preparation of any AI tool requires data that contain elementary expressive pieces of phenomena that may be susceptible to be transform into information and knowledge, to achieve this informational stage, we need to introduce our third element, 3): computational power. It is required to have the processing capabilities to analyze and synthesize the data, many models demand huge amounts of data in order to produce significant and tangible results, without the computational power many models would not be able to be create, without the processing capabilities an actual representation of AI would not be feasible. Intellectual emulation requires to play within the time frame responses expected and normalized by human beings. Comprising these three elements we can form an overall view of AI and its interoperability between the theoretical math models, the data and the computational capabilities to mimic an intellectual process.

AI is becoming an innovation in the way we perform innovation, due to the speed to process data, it is altering the "know-how" of innovation practices, and it shows promise to become a disruptive tool, reshaping not only how to do innovation but also what it means to innovate[22].

Traditionally, innovation is understood as the introduction of a new product, service, feature or enhancement that delivers augmented perceived value and enables a consumption behavior modification to users and consumers. As a result of the introduction of AI, the understanding and value of "novelty" no longer rely on the ability to render different or varied versions of a new deliverable but to generate a design or proposal that is aligned with a set of requirements and expectations; in other words, the manual labor of renders is not really providing an added value, especially after the launch of Gen AI tools but to harmonize a solid product, service or enhancement with the environmental-contextual and user's demands, in figure 8 we can see a simple and high level view of a proposal for an AI road-map business model innovation where the very first step is to have an understanding of AI and organizational capabilities, this represents the relevance of the organizational context to thrive in the implementation and adoption of AI.

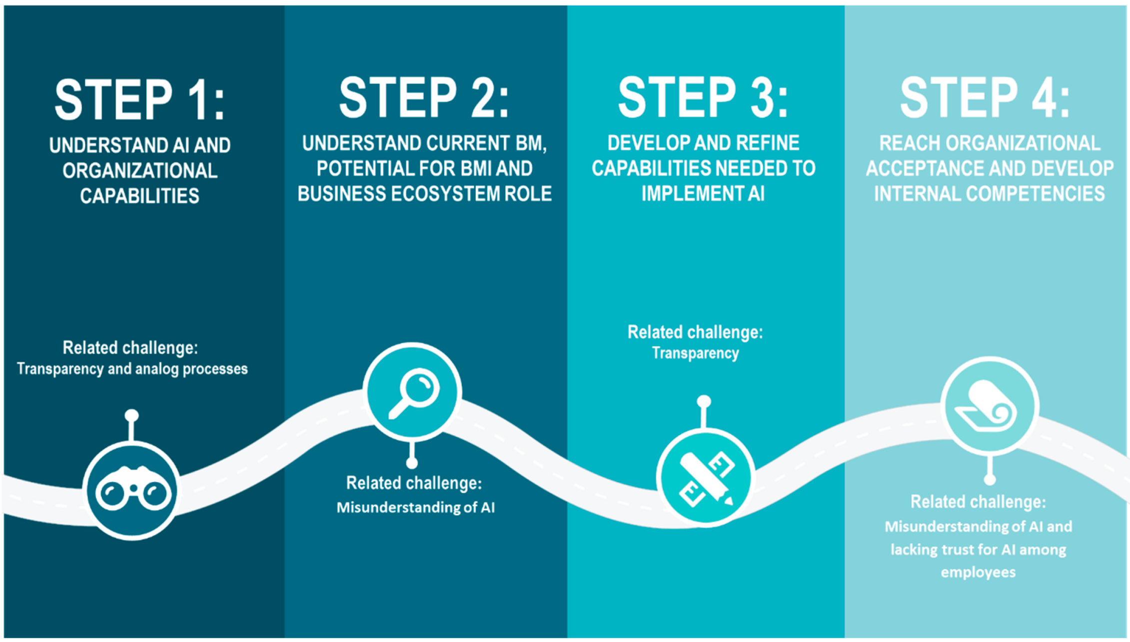


**Figure 8:** A Roadmap for business model innovation. Source: taken from [47]

We may consider that the former necessity to manage innovation is increasingly becoming -not a necessity- but a inbound feature of innovation, i.e., in light of AI, management cannot longer be excluded-or optional- from innovation, on the contrary, it may be understood as a build-in set of skills and knowledge to develop it.

This means AI is expanding the necessity of management because of the introduction of AI capabilities which require a human-technical and managerial assistance to cooperate in the innovation pipelines and processes. Fur-

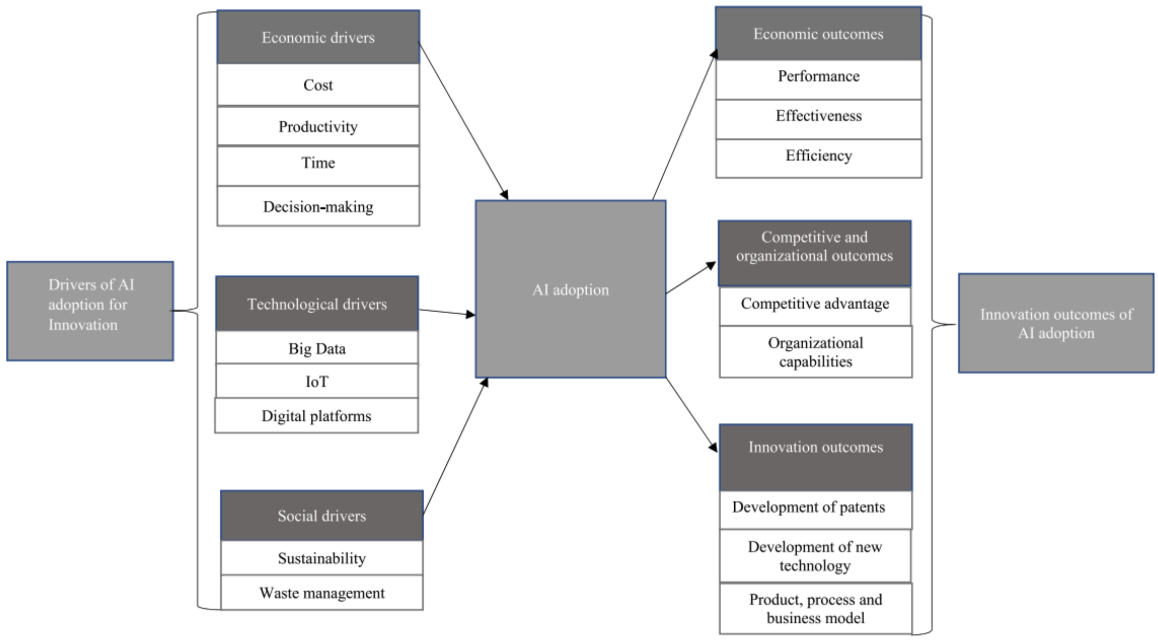


**Figure 9:** AI drivers for adoption. Source: taken from[48]

thermore, without the proper coordination and assistance to leverage AI into the innovation pipelines, the effect of AI may be counterproductive, slowing down and hindering the whole strategy and operation of innovation. In Figure 9, a set of drivers are depicted as an example of how the technological readiness of the company and its environment may facilitate the adoption of AI.

Innovation, and particularly technological innovation demands several iterations to provide benefits and value, according to some methodologies such as agile, this value not necessarily have to wait until the fulfillment of a product or service, it is feasible and convenient to add and deliver value continually and periodically. This methodological approach helps to understand how AI may cooperate into the companies' processes, reiterative and incremental value development is precisely the way AI and machine learning work. Learning algorithms leverage data and perform analysis, pattern detection and insights are found thanks to the repetitive screening of data. For instance, machine learning and technological innovation employ models to run their algorithmic processes, and also, both trying to discover valuable insights as an output of their work. Converging the procedural aspects of AI and IM as well as their reiterative nature to produce outcomes, it seems intuitive to realize how both may be attuned to support each other.

## 1.4 Innovation, Risks and Events Management

Project management is a well-studied and seasoned field of knowledge. Its applications are vast and diverse, and their practices, recommendations, and directions have been successfully employed in endless organizations to drive all sorts of endeavors to a fruitful stage. The project management institute (PMI) defines a project as a: "A project is a temporary endeavor undertaken to create a unique product, service, or result"[49]. It can involve anything from the glamorous events of fashion week to humanitarian aid efforts overseas. More specifically, a project is a series of structured tasks, activities, and deliverables that are carefully executed to achieve a desired outcome"[49].

One of the key areas of project management relies on risks management; in practice, risks are commonly managed as events that will potentially have a negative impact on a project and must be avoided. On the other hand, as the PMI describes -risk- as an uncertain event or condition that if it occurs, "it has a positive or negative effect on a project's objective"[50]. With this approach, all kinds of events implicated on the project are susceptible to be traced and assessed by top managers, regardless of the the positive or negative impact on the project's development.

Risks are particularly important when it comes to innovation projects, simply because innovation tends to be much more risky than well known projects; i.e. innovation implies and entails risks as an intrinsic part of its nature.

This description of risks is more accurate for project management implications, since the accomplishment of a project also depends on the occurrence of positive events that lead to the project achievement, not only on dodging negative events. The success ratio of a project depends on both the realization of the positive-impact events, and the non-consolidation or failure of the negative ones.

Risks management is an essential task when a project is being carried out within an organization, doing an adequate risks identification and assessment in the right moment is critical to avoid project's failures, since one of the most common reasons for project's failures is closely related to negligent risks management[51].

The timing of the events assessment and managing is also critical, since the risks are not always punctual and consistent over time: risks are generally assessed taking into consideration both, the probability of happening and the impact entailed by its consolidation at the assessment time. The potential impact of a risk that has not been properly assessed may become one or several issues, for instance: the allocation of unplanned resources, whose costs can lower the probability of achieving success rates of the project milestones. Risks that are treated neglectfully can compromise the project's objective and overthrow the delivery of services and value.

Risks in projects could be considered as variables over time instead of punctual assessments at a specific instant, allowing the top managers to make more accurate decisions if needed. For project innovation, risks are particularly important, since innovation commonly poses higher risks. This is one of the reasons why AI may play an important role in innovation projects; measuring, monitoring, forecasting, analyzing and managing risks with the assistance of an artificial intelligence may be very convenient if it actually allows to transfer manual and laborious work to a digital artificial assistant. Innovation is deeply embedded into the relentless search of value generation for costumers. Value generation is one of the vital concerns of businesses, value generation can be defined as the benefit that a customers get for a product or service versus its cost or price, it can be understood as a difference between these two elements[52]. Artificial intelligence is now playing a very important role in innovation processes for the generation of value in products and services [53] [54]. The introduction of AI is also setting the stage to reconceive the service-dominant logic, AI is challenging the current understanding of dichotomy of operand and operant, since AI can be understood as a hybrid resource, i.e. operant and operant may evolve into a dynamic spectrum [55], these statements have the potential to reshape the traditional understanding of service dominant logic of services proposed by Vargo and Lusch in [56] and even at particular industries such as healthcare, as discussed in [57].

## 1.5 Innovation with Artificial Intelligence

Firms and organizations have a growing interest to explore and exploit the benefits of many digital emerging technologies, AI is not the exception. However, countless organizations do not have or do not even know the required capabilities to implement AI into their innovation management (IM) processes. At least, a set of basic skills and knowledge is necessary to carry out a promising adoption of AI tools. Additionally, even directors, managers and strategists often lack the elemental knowledge to figure out where to start an AI adoption and what are some of the potential benefits and use cases.

AI is being positioned as a competitive advantage, in this work, we propose a methodological machine learning approach that encompasses several and simple use cases where companies and even SMEs can leverage and implement AI to improve their overall innovation performance. The aim of this methodology is not to provide a multipurpose or general-purpose path to tackle all the challenges and requirements of a functional AI tool, but to unravel a technique where healthcare companies and users can get benefits from the state of the art.

Business and value proposition models, as well as business cases are some of the most employed artifacts when managers and educators are reviewing and analyzing innovative business projects [1-10]. The value proposition canvas design [11]is among these highly used tools. This canvas design alights two fundamental aspects, a value proposition, and a customer segment. This sort of models can enable business innovations when they are integrated with data manipulation and AI techniques such as support vector machines or neural networks [8]. These models and many other such as SWOT analysis, are an example of the sort of tools that innovation managers employ when trying to conceive, identify or address potential innovations or improvements that may be valuable to organizations. At the bottom of all these tools we encounter a common fundamental analysis: conceptual innovation. In other words, all business, technological and creative analysis ultimately can be deemed and expressed in sentences, after all, the tools and techniques we perform are meant to be served as guides and facilitators to envisage 'ideas-concepts' that might be regarded as valuable for the firms' interests. Therefore, it is evident that all value propositions and innovation insights are enunciated and parsed in words-concepts. Conceptual innovation is also relevant in the field of scientific knowledge [12]. This can be synthesized in a simple sentence: When we think, we think about concepts. When we seek to innovate, we bring up and arrange concepts that will allow us to express creativity through ideas. After all, innovation is ignited by the capacity to postulate thought in the shape of words.

The creative process of innovation is intrinsically related to the creative process of concepts because we elaborate our ideas leveraging language. The process of creation and ideation cannot be separated from the process of conceptual articulation.

The typical IM processes require a long time to evaluate their project proposals. Models such as AIIA(artificial intelligence innovation assistant) [13] may allow to run algorithms that are interconnected providing a holistic AI evaluation of a given project. This can set the path for performative innovation. Performative innovation means: The mere articulation and expression of an idea or thought can be considered as a contribution (regardless of how small this might be) to the process of innovation and creation. Any idea or thought, solely for the fact that is being enunciated is already a step forward in the creation process. Whether this creation is valuable, apt, reasonable or not, that's part of the evaluation of the proposition. Even if any given proposition for any reasons is rejected, the proposition itself is a step forward in the search of innovation because such proposal has been stated and analyzed. This can be synthesized in the following statement: Conception and enunciation is already performing a partial innovation, "discourses, which are articulated in words and concepts, do not simply represent phenomena but constitute them when felicitous conditions exist" [14].

Using AI to simulate such condition would allow us to visualize innovation scenarios based on ideas and projects that are being proposed, in such case, it would be possible to propose an idea which can be simulated into a whole innovation project. This is graphically expressed in models such as AIIA [13]. As it can be seen this sort of model reveals that any modification is susceptible to alter all the layers and elements of the system. Since all events within the system are intrinsically interconnected. This performative innovation is enacted as simulation of a whole IM project.

When we speak, we explain one idea by means of other ideas, this describes the foundation of what fractal innovation is. A singular idea or concept may be understood and described as a set of endless words-semantics, in this way, "the meanings of linguistic expressions are determined by the contents of the concepts and thoughts they can be used to express" [15]. The linguistic philosophical discussion is far beyond the scope of this document, nevertheless, we leverage the approach that: each concept-word may have a common, normal, or most frequent understanding of its meaning, which will be more accurately called as normal semantic content (NSC). This normality allows and facilitates communication and understanding of concepts, for instance: the concept 'friend' may be normally understood as: "a person whom one knows well and is fond of", similarly if we ask again what a "person" means, we will respond by presenting a new set of concepts to express what a "person" is [14]. Fractal innovation leverages this linguistic knowledge. It focuses on the semantic endless loops that can be found when analyzing the concepts and concepts within concepts.

A conceptual construction articulates the product, and it allows to understand what features, characteristics and functionalities are being suggested and eventually produced, distributed, and consumed. For instance, concept semantics have been proposed to serve as drivers for product innovation design, concept semantics can be employed when rendering new computer aided product-service proposals [16]. For instance, business agile frameworks and methodologies such as SAFE and Scrum Master employ features, stories, epics, etcetera, to facilitate the conception, and ponderation of a product to articulate its value [17]. These features, stories and epics behold the concepts within their sentences to understand the project's work and to outline the value it will provide to the customer.

When we look at the vast majority of companies and organizations, we can tipically decant that the value provided by organizations is materialized or embody into products and services, regardless of the its combination or mixture,generally speaking, the customers experience benefits through the value granted by these elements. Both, products and services are delivered via processes, which can be understood as standardized activities that follow a harmonic order to allow defined outcomes. These expected and desired outcomes are regarded as helpful by the customers who are willing to pay for them. In order to structure and organize a sustainable and ongoing production of such outcomes business models are built, serving to characterize the essential functioning and elements of an organization and its interactions. The operative functions of an organization may be simple or complex, but either way, they represent the basic structure of their labor. As a consequence, within all these levels, innovation is wanted to remediate and promote the growth of benefits to the customers and users. Futhermore, innovation seeks to set an enviroment of relentless search of opportunities to satisfy demands and to rise above expectations presenting updated benefits with augmented value.Here is where AI finds its way into the world of innovation. Employing engineering resources, AI is capable of replacing and assisting humans within the innovation processes, becoming a strategical differentiator and partner in the business models, impacting the generation of products and services, i.e., AI is being inserted as a virtual human agent with limited capabilities that has the potential to disrupt or alter business innovation operations.

The following image depicts in a simple manner, the way in which AI is able to impact the organization at different levels.

| | LEVEL 1: EXPLOITING | LEVEL 2: EXPANDING | LEVEL 3: EXPLORING |
|---|---|---|---|
| **SEARCH APPROACH** | Able to successfully exploit both the problem and the solution spaces | Able to explore and redefine either the problem or the solution space | Fully able to explore and redefine both the problem and the solution spaces |
| **CHARACTERISTICS** | - Used to overcome cognitive information processing constraints<br>- Can deal with more data<br>- Able to process many different data sources | Either:<br>- Able to discover new ideas and opportunities<br>Or:<br>- Supporting humans in developing more innovative ideas and solutions | - Exploring new avenues in the innovation process<br>- Generate and create innovative and creative new ideas<br>- Explore new ways of defining problems<br>- Explore new ways of addressing problems |
| **MATURITY LEVEL** | Realizable applications | Initial implementations | Sandbox experiments |
| **AUTONOMY LEVEL** | Human-designed AI systems | → | AI systems with increasing machine autonomy |

**Figure 10:** AI maturity levels. Source: taken from: [58]

Figure 10, allows us to see that there are different organizational levels of adoption for AI, the readiness of companies and firms to implement AI into their products, services, processes or even as an strategical component will vary.

This table also depicts a few key characteristics of the sort of applications and uses of AI depending on the level of technological appropriation. From sandbox experiments to realizable applications, AI requires an understanding of the organizational capabilities to find suitable use cases and business cases to display its potentiality and value, e.g., a company that seeks to expedite its innovation processes would require a deep understanding of such processes, not only a mapping but a study. In addition, the inclusion and implementation of AI practices require a certain degree of digitization, for many companies this is not news, but for the millions of small and medium businesses and enterprises that sustain the global economy, digitization is still out of reach. Similarly, the adoption of AI as a facilitator for production innovation is not without limitations, although there's a huge variety of digital products and services that can easily integrate AI as part of their functionalities and values, many industries are still insecure about the role of AI and the way in which it can bring a real and tangible benefits to their costumers.

A justifiable question that CEOs and businesses are posing relies on the whether AI is actually going to deliver the expected value, and its respective profit. One must not forget that timing in terms of marketing and technology is a crucial factor. Timing may determine the success or failure of a innovation project, the same applies for technology, timing can easily become the decisive factor in terms of consumption, adoption and value perception.

This is precisely why, AI shall also be considered as a potential business model disrupting agent. The ability to create models and tools that can replicate human activities such as, text writing and analysis, video surveillance, among many others, means that the ontological conception of the business as a human to human relationship may now be mediated or accompanied by a human-machine relationship, i.e., machines can be considered business partners, as long as they become an essential part of the business decision making process. If within a company, AI has reached the level of "realizable" applications described in Fig.5, it means it is already operating alongside human beings on tasks and activities that help to solve problems or to find optimized solutions. This level of support can be considered an assistance or even a partnership.

The processes of innovation demand time and effort that can be delegated to machines, scrubbing information, running scripts to find trends, monitoring analytics to detect risks and opportunities, sensing mismatches or misfits for classification problems etc. Naturally, the development of these solutions requires an investment, but once implemented the AI allows to enhance the speed of activities, minimizing costs and effort.

# 2. A Methodological Approach to do Artificial Intelligence Value Propositions

One of the most basic and fundamental principles of human behavior relies on the pursuit to satisfy its necessities. We can come up with an endless list of necessities, from the most basic one, such as: Feeding and housing, to much more sophisticated ones, for instance: The necessity of status and recognition or the necessity of social and affective relationships. The constant search for satisfaction of needs raises the concept of value. We value something that we deem to be worthy of our attention, and as a consequence we can rank the level of value according to the level of need and viceversa. This idea is depicted in a very simple model in the typical value proposition canvas.

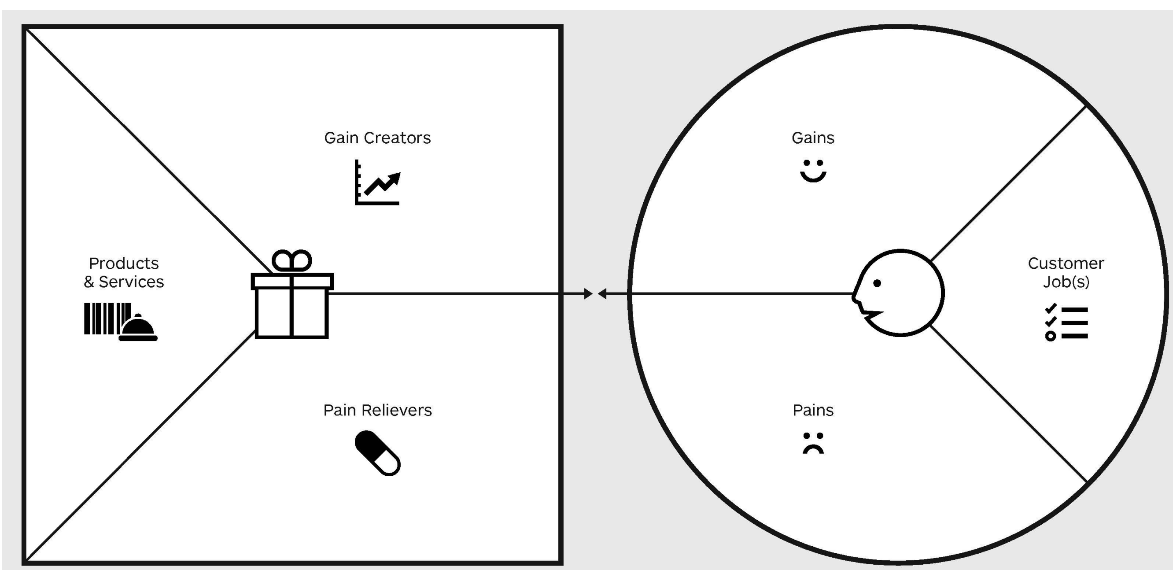


**Figure 11:** Value proposition design. Taken from: [59]

This canvas value proposition interlaces two domains, offer and demand. In some way, the value proposition is the core of companies and firms; it creates a mutual link or interest. However, the information availability, the awareness and knowledge to match (in the best possible way) offer and demand is not that easy. There can be a complex and intricate system of products and services to offer, and customers or users do not necessarily articulate clearly what they are looking for, so the pains, gains, or jobs they need may be poorly described creating ambiguity to understand how to address their necessities. But here is precisely where AI can contribute. Computer systems and interconnected networking devices are able to track and save data of human behavior, preferences, and proclivities; employing these data may companies have been able to propose AI recommendations that seek to address the customer's preferences and that are constantly evolving based on the feedback their receive from humans to improve the quality and accuracy of their predictions. This sort of systems integrate relatively simple algorithms such as support vector machines or K nearest neighbors. They rely on the premise that human behavior is partially predictable, and a good customer profiling can facilitate the predictability of their decisions and choices.

A very intuitive and simple way to explain how an AI canvas value proposition model works is to imagine two sets A and B, where A represents the offer, i.e, the products, services, pain relievers and gain creators and B represents the demands, pains, gains, and customer's jobs. Having these sets, how could we interconnect and match the right elements of A with the respective elements of B? So, this becomes a problem of suitability, appropriateness or adequacy. We seek to select the candidates-elements available in A that satisfy the best the requirements posed by the vacancies-elements of B. Let us provide a couple of examples. Scenario 1, a woman says she is going to the beach, she plans to stay there seven days, this woman is visiting Puerto Vallarta, México. She's coming from Toronto, Canada. This is all the information collected for A. For B we have several products: Laptop, bed, towel, pencil, cup, notebook, sunscreen and a wrist watch. From B, what product has the highest probability to address the needs that this woman will have during her time off in México? Scenario 2, a Man is traveling from Cartagena, Colombia to Dusseldorf, Germany. He's planning to visit museums. That's the information for A1. For B1 we have the following products: T-shirt, jacket, sun glasses, lap top, shoes, dog's leash and 45" screen. The same question remains, what product should we offer as "best candidate" to address the potential customer's needs? The response is simple, but the answer might not. Naturally the best candidate is the one that the customer requires the most, but the question remains, which one is it? Does the customer know? Does she/he even need a product? We can sort out the products and needs to attempt to figure out which are the best candidates. There are many different approaches to solving this problem, however, let's review one of them.

Employing a technique of natural language processing (NLP) and semantical proximity-relatedness such as word vectors. Word vectors allow us to find conceptual proximity based on contextual semantics, in simple words, based on the proximity of one word or concept among others, we take a span (window) to try to establish the semantical closeness. For instance, let's review the following sentence: *"The queen expressed her anger immediately after she listened to the news, this outburst cost her more than she imagined"*. In this sentence we can easily notice that we are talking about a female thanks to the words: she and her... if we wanted to figure out whether queen is closest to male or female, employing this sentence's words proximity we could intuit it. Now, if we employ a similar method to solve our Scenario 1 and 2, we would be looking for words in set B whose proximity is closer to the needs of set A, i.e., the woman who is going to the beach... what words may be closer to the contextual semantics of beach?

Laptop, bed, towel, pencil, cup, notebook, sunscreen and a wrist watch. Intuitively we might say: towel or sunscreen. And so these items might be closer to the semantical field of the concept "beach", and we can leverage all sorts of texts to feed a system, where we can review which concepts are closely related to others. We can apply the same to scenario 2, where the man who is traveling to Germany, in this case it does not seem so easy to come up with the best or closest concepts to address the needs, however, we could practically disregard the 45" screen, since we are not frequently going to require a large screen to travel to another country. So even if the answer is not found, the method can help to discard outlying options.

Needs and demands are expressed in words, when we seek to address those demands we are also trying to find the concepts that best fit those needs which are ultimately embody into a product or delivered as a service, this means all products and services are susceptible to be conceived and expressed as a collection of words.

Looking at the canvas value proposition model we can propose a methodology where we attempt to find the best match of the demand domain and the offer domain. This can be seen in figure 11.

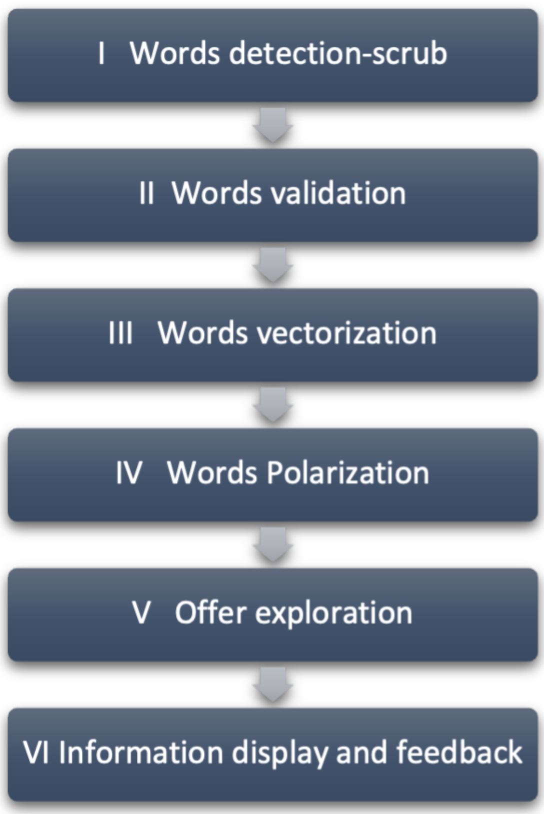


**Figure 12:** Value proposition methodology. Obtained from:[60]

The methodology consists of six steps. Let us explore each one of them.

I. Words Detection-Scrub

The detection-scrub could be implemented using words frequency such as td-idf in python or any other counter of words. The goal is to know what the most frequently repeated terms in a document are. Similar examples of this step can be seen in [61]

II. Words Validation

A steering committee, the engineers, scientists, managers or any member who is involved and responsible for the VPD innovation process should review and validate the selection of key words. This validation could be compared to any marketing data or customer profiling that might be available. Also, this validation could omit human supervision if there's a reliable digital text or corpus containing the customer's information. In this case a simple automated scouting to match similar concepts from both domains may suffice [44].

III. Words Vectorization

Leveraging python libraries such as Gensim we can easily employ word2vec to transform the key-selected terms into vectors. Once we get the vectors, the same sort of libraries can help us to find the most similar concepts that are around our key terms. These "neighbor" concepts are fundamental to expand the offer exploration during step 5. This collection of words can be stored using a python list or dictionary to facilitate its usage, publications such as [62][61] and [63].

IV. Words Polarization

Although several methods may be proposed to used words similarity to find antonyms, our approach is to simply load into python a dictionary-corpus of antonyms to relate the key words with their polar or opposite concept. It is important to highlight that we are considering mainly adjectives, verbs and words that are susceptible to be polarized, it is evident that nouns are unlikely to present an antonym. For instance: the noun -darkness- can be easily polarized into -lightness, but -car- doesn't really have any polar concept. As a takeaway, it is a duty of the developers or data scientists to understand the best way to identify, process and categorize their key words. An example is NLTK library that allows to categorize and tag words of sentences. In summary, words polarization requires a subroutine to classify and organize the key words for the dimension of offers (pain relievers, gains, products and services) before running into the exploratory phase. Also, a second validation of the -opposite- key words selection after this step is highly recommended, once more, either human or automated supervision or is plausible. Polarization of concepts is a novelty of this investigation project, however, similar applications that apply words embeddings to measure and study social polarization can be seen in [64] as well as a similar mathematical variation of polar coordinates for words embeddings is found in [65].

V. Offer exploration

Thanks to the identification of key words, we can use these to explore several and diverse data sources or corpuses such as social networks, web sites, or patent repositories to extract tentative solutions that are published in these documents. For this stage, even pre-existing AI tools could be employed, such as chat-bots. The offer exploration step seeks to find the resources, solutions, products, services, etc. that are available or related to the customer's needs and desires. This step may also require additional steps or subroutines to refine the results of the key words, it is expected to have several search iterations to do a proper mapping of offers, further references of the importance of this exploration for the functioning of AI can be found in [66].

VI. Information Display and Feedback

This section contains the findings of the whole value proposition design, it embodies the fit that the whole methodology is meant to find. Naturally, the information display will be intimately tied to the offer exploration capabilities. For example, the implementation of a chatbot will display information findings based on inquiries, while the use of corpuses or data bases may require additional mining labor. For any of these instances, it is fundamental to understand the interface that will allow us to download information and the way to provide feedback. In python, an easy and common approach to address this step is to do a simple print command to display the variables that contain the information. In this way we can review and additionally provide further inputs.

This methodology seeks to facilitate and demonstrate how organizations can implement use cases employing AI with a relatively simple use of machine learning tools. It also allows to see that employing semantic fields, it is possible to find out potential algorithms that can benefit and ease the search of products, services and gains.

One the most fundamental contributions of this methodology relies on the the words polarization. The polarization of concepts is not always an intuitive approach, the systems must be properly train to understand the surrounding concepts that could potentially address the customer's needs and desires. For instance, the word: "thirst", as antonyms we can find: "disgust", "repulsion", "aversion", so the polarization of the concept must be accompanied by a context. If we find the expressions: "spiritual thirst" and "it's hot, I'm thirsty", the context points out different ideas. This is why polarization may not always be the opposite or the antonym of the concept but rather the complementary or lacking side of the expression. Another way to look at this methodological model is to recall the typical "pull" and "push" marketing strategies. In simple words, the pull strategy seeks to insert a good into the market explaining its benefits and attempting to accommodate it into people's life, customers or activities. By the other hand, the pull strategy acknowledges unresolved necessities within a potential market and attempts to relieve them, "pulling" the requirements from the potential consumers rather than pushing them to concede to acquire new products whose value was not necessarily identified.

In summary, the six steps methodology proposed allows to address tasks that require to link offer and demand to close a pain or demand gap from a pool of possibilities, and it can be applied to countless scenarios where we can semantically relate and correlate concepts that are tied to a set of products and services. So an oversimplification of these steps can be expressed as: a methodology that facilitates making matches of customers'demands and market's products and services availability.

## 2.1 Value proposition use cases for small and medium companies

Unlike many large corporations small medium companies and enterprises (SMEs) as well as businesses often lack the knowledge to develop complex AI solutions and tools to include them as part of their innovation processes, products or services. In some cases, there's an adoption and inclusion of software and tools that leverage the labor of the companies, but for state of the art technologies, the inclusion may take years or even decades. Many SMEs are not even able to buy licensing of office software, let alone pay software such as customer relationship management software (CRM) or enterprise resource planning (ERP). As a result, countless businesses are simply unable to reduce the technological gap between their transnational counterparts and local entrepreneurs. Furthermore, in emerging economies, it is required to review the best alternative to implement modern technologies to enhance areas such as education, tax management information, healthcare and medication distribution, legal cases status etc. Although it is undeniable that LLM and chatbots have become quite popular, it's not easy to manipulate old archives containing technical language and ask an LLM to ingest it and learn it from it. The methodology described does not seek to become a generic or general solution to show how to tackle the intricate effort to implement AI systems from scratch. It shows a path to facilitate the development of an engineering algorithm to exploit the uses cases that the value proposition canvas model can offer in a wide range of businesses and firms. The methodology has a defined purpose it does not have a large overall multitasking objective, it is not a chatbot or an autobot, it is a methodological path to facilitate or enhance the process of value search leveraging AI.

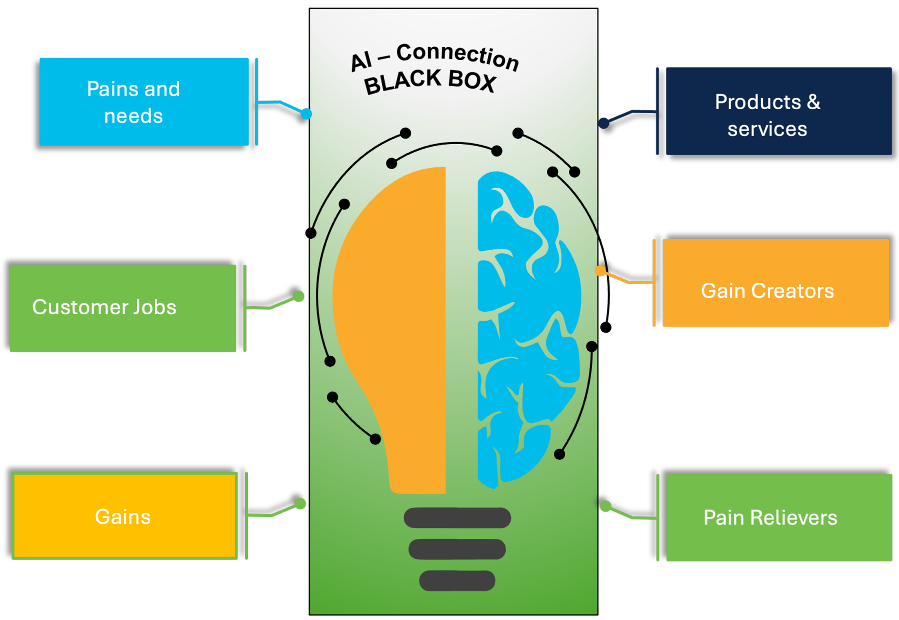


**Figure 13:** Value proposition including AI.

The interaction of AI as an intermediary has several direct implications and use cases. Let us discuss the following potential applications simply for explanatory and exemplification purposes. 1) Healthcare industry. There are measureless bureaucratic institutions whose internal processes to handle medical appointments take months, not to mention that in numberless cases the users don't even know where and how they can receive medical attention, AI systems can facilitate the preliminary needs to expedite the revision process of patients, there are numerous applications that already operate to ask for general symptomatology in order to offer a tentative (no definitive) classification of medical needs employing a triage.

The incorporation of such system into the current processes is not trivial, nevertheless, even simple use cases such as planning demand or level of effort and prioritization protocols for medical appointments and emergency services becomes crucial to save lives and to detect workloads. For instance, a machine learning model that has been trained to process a simple medical triage employing classification algorithms can facilitate the management of critical patients and the availability of medical staff and resources to assist such cases. 2) Legal processes and report of criminal cases can be mediated or have an incipient analysis and evaluation employing AI systems. Via text mining, NLP, and especially large language models that have had a huge acceptation and inclusion in the last couple of years can be leveraged to expedite the initial exploratory and precursory processes. There are many countries where legal procedures can take years to review and process.3) A company that is constantly spending hours to elaborate marketing reports to better understand their customers and their purchasing behavior can utilize AI to quickly find patterns and correlation events that may become relevant for their investments decision making, e.g., we create a model that links the most frequently purchased or requested products of people who have diabetes and then we compare the availability and supply of such product in the distribution centers to compare offer and demand volumes. Indeed, this is a common practice, but the expedition to perform all this analysis via AI becomes quite relevant to minimize costs and increase lead times of processes.

This sort of applications may benefit medium and small organizations that can afford simple engineering implementations to start integrating AI into their regular practices. Often, simplicity works much better to demonstrate the value and functionality of a new deployment, unlike sophisticated solutions that could pose many threats and unknowns. There are many use cases that SMEs are able to incorporate with the support engineers, and collaborators from diverse business areas, such as marketing, sales, procurement, etc. For instance, if we think of the widely and well know Maslow's hierarchy of needs[67], we could use it as a reference to teach an AI system to classify products and services, and then use it to compare a set of users' purchases behavior to attempt to classify the users into a section of Maslow's levels. The output of this exercise can serve as a single input for a more robust customers' analysis classification or profiling. Now, we could employ this profiling-classification analysis as a pre-evaluation of tentative customers' needs, which is precisely one of the key domains of the value proposition model.

Understanding customers' needs, pains and gains is extremely benefitial. In a way, to understand what a customer truly desires solves much of the problem of value delivery (assuming a person is actually able to know what he or she desires). Obviously, the rest of the problem is having the solution available to remediate the requirement. As a result, we can propose a simple equation for the value delivery in terms of the value proposition model:

$$V = R + O. \text{ (1)}$$

Where «V» stands for value, «R» comprises pains, needs, customer jobs and gains; and finally «O» contains all products, services, gain creators and pain relievers. Now, with this simple equation we can exploit mathematically a few models to try to simulate customers' demands. If we take R and turn it into a multidimensional gaussian distribution, we can represent R such as:

$$R(x; \mu, \Sigma) = \frac{1}{(2\pi)^{\frac{n}{2}} |\Sigma|^{\frac{1}{2}}} \exp -\frac{1}{2}(x - \mu)^T \Sigma^- 1(x - \mu). \text{ (2)}$$

We can note that each of the dimensions contained by sigma may reflect the normal distribution of a single desire, whereas a the multidimensionality can represent a set of desires that are bond in this case by the model( and the features and restrictions) of this distribution, an example of this application can be seen in [61], where a multivariate gaussian is utilized for documents' representation from word embeddings. Once the model is obtained, values such as the Mahalanobis distance can serve for multiple applications to understand and measure customers' behaviors. This assumes that we can represent a customer's need or demand based on average (mean), and variance. Both factors can be easily retrieve from customers' purchases logs or similar registers. In the same fashion, we can represent product availability or offer as a gaussian distribution. Moreover, R could also be modeled as a time series- a generic example is depicted in Figure 14-, and if we decide to equal demand and offer quantitatively, then R and O become the same value, therefore, in this scenario:

$V = 2R.$ (3)

Or:

$V = 2O.$ (4)

In this equation the premise is based on the assumption that demand keeps $50\%$ percent of value proposition and offer keeps the other half of it. However if we modify these values, then:

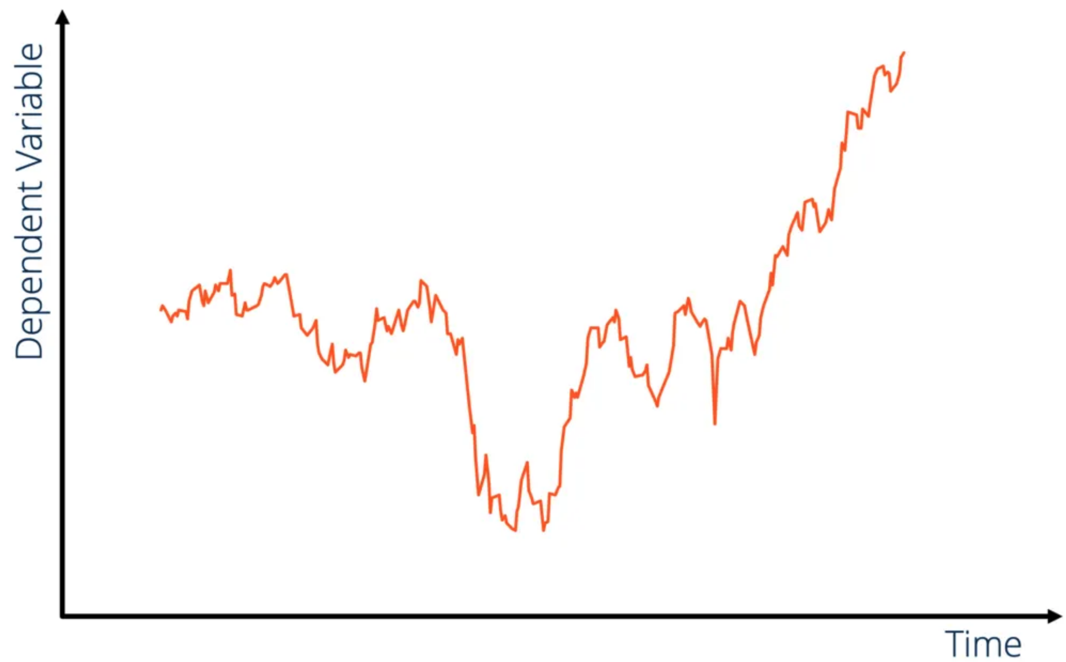


**Figure 14:** Generic Time series. Source: taken from: [68]

$V = k_0P + k_1O.$ (5)

In this expression, we get a pondered equation, where we establish that:

$k_0 + k_1 = 1.$ (6)

This means, the value proposition is divided into $k_0$ and $k_1$ in any given numbers, where the total is 1 or $100\%$.

Let us show a couple of examples to explain these simple equations. The human need for it is indispensable, but we can consider it is an extremely abundant resource, however the demand is fundamental for human life, humans cannot survive without it, so, just for explanatory sake, let us establish the demand as extremely important, but the offer as extremely irrelevant, simply because there is good enough air free and available to fully satisfy human needs -at least for now-. We represent this in the following equation:

$$V = .99P + .01O \tag{7}$$

In this equation, we can see that in terms of human perception, the value of air hinges on human demand, in other words, availability is not a concern, the whole value of air is based on the fact that it is indispensable for human life. In a similar way, we can use the example of water.

This substance is crucial for human consumption, but the availability is much more reduced compared to air, so how could we model «k0» and «k1» now? This is where AI and tools such as machine learning have great relevance, where optimization and automated calculation of values become necessary. If we say that the water demand of a given population is constant «W» but the availability is variable, we come up with a simple linear equation, perhaps one of the most basic AI model that we can represent:

$$V = k_0 + k_1 W \tag{8}$$

Indeed, this may be an extremely simplistic model for a water consumption simulation, but it does reflect an underlying aspect, a way to estimate optimal values of offer (water) based on a constant value of demand (consumption), or conversely, the estimation of a variable demand given a constant offer. As we have mentioned, availability and scarcity play a key role in terms of value proposition. Let us map this example to show how these equations can be the foundation of a minimal AI system.

First, we set a constant value demand for the population, we will call this value «D». Then we present a time series called «W» that represents the availability of water reserves to satisfy the demand of people. One way to build the system is to set a gap limit to control water flow, just like a typical automated control system in engineering sciences.

We set some preliminary premises, for instance:

A) If water availability decreseas, the value increases.

B) If water availability increases the value decreases.

C) If water availability remains stable, the value also remains stable.

For scenario C the gap or Delta is zero, but for A and B there is always a difference whether positive or negative between offer and demand.

In fact in [69] we can see a proposal to forecast water consumption employing neural networks and time series.However, an oversimplification of a

AI model such as the one employed could consider only a delta between D and W, in scenarios A an B. If rather than a time series -which indicated an ordered set of values- we consider a function that expressed the perception of value in a given time span «t»; we could also conceive it and represent it as a classical line integral:

$$\int_C f ds = \int_a^b f(v(t))|v'(t)|dt \tag{9}$$

Notice that the representing value in this way displays an accumulation of "value perception" in time given by C. This remark recalls the fact that scarcity as well as availability are particularly time sensitive for value perception.

Circling back to our methodology, we are able to insert this model to generate curves' variances in time or time-series data to train a model, a simple neural network for instance. In our methodology we present words vectorization as the way in which we transform a set of concepts into a mathematical language, however, we have presented here the gaussian distribution and the linear integral as models that can fetch data to "tokenize" parameters to represent value and polarize it to link it to its respective solution or best-fitted solution.

It is fundamental to state that, at a computational level words are numbers, so the "parametrization" and "tokenization" of words is essential to be able to apply computational techniques. In the liner integral expression for instance, the consumption of water that we called demand, can also be expressed in terms of -level of satisfaction or insatisfaction- or customer sentiment level etc., and as such, we can directly relate water demand and supply quantitatively with customer contentment. To put it in another way, we assume there is a correlation between the level of water supply, availability and consumption and the level of customers' necessities fulfillment. This means we can establish certain threshold values or teach the AI system such values, in which low levels of supply with respect to consumption will become a conceptualization of complain, anger, distress, etc. So for the computer, water scarcity or low water supply will be represented as a set of numbers under a threshold value, and accordingly a pain reliever, a gain or a job to be done should be found to address the situation.

If we apply the same concept of water consumption to a commercial or shopping store, product consumption or demand can trigger a system to detect trends and provide alerts.

At this point we can picture the bridge with AI innovation, given a situation a solution or an improvement of a solution is required, based on a problematic situation or a necessity, what possibilities and choices are there?

In a typical innovation pipeline the exploratory phase is one of the core aspects. Visioning, ideation, brainstorming are just some of the exercises that we find in this stage. At this last step, as part of the words exploration, we can breach our VP model with a much broader proposal, not only a system to assist the value generation but to support the whole innovation pipeline.

# 3. Artificial Intelligence Innovation Assistant

Innovation has become an essential development area for all sorts of organizations in order to remain competitive and increase the value of the services, products and activities they perform[70]. Innovation has always had a close relationship with technological momentum. The status and evolution of technology plays a key role to exploit and capitalize new breakthroughs and discoveries into actual and tangible benefits for people. In this way, innovation also has a direct social impact, in terms of 1) technology development 2) remediation and facilitation of needs (via products and services) 3) technology adoption 4) processes enhancements and ultimately 5) incremental users' satisfaction and life's quality. The interaction between innovation and economy has deepened in the last decades [71], where there has been a clear acceleration in the pace and release of the technological evolutionary path. As part of this evolution, AI took an important resurgence in the last decade and particularly in the last lustrum[72]. Unlike any other period of time in history, brand new research fields emerged at an extremely quick pace, digital companies showed an exponential growth due to global internet connectivity and commercial networks, the introduction social network platforms also became new means of publicity and media content sharing, in general, the interaction of people with machines strengthened. Internet became a basic and fundamental key source of communication, email, instant chats, teleconferencing, are just some examples of means of telecommunication that became extremely popular and transform people's behavior, a new shape of digital social human interaction was created, such as dating digital platforms or applications and remote jobs. One of the results of all transformations was the productions and availability of data; massive data (also know as big data) were being generated and stored. These data and the creation of super-computers with extremely powerful processing capacities of GPUs, CPU and TPUs allowed the creation of new AI models[73].

AI models, whether simple or complex are behind all current AI applications. All models rely on, at least, the aforetold elements: Mathematics, data, computational processing. However, with the recent exponential growth of digital data production, and its availabilty via internet, countless AI applications became feasible. And as a consequence, innovation was not out of the scope. In papers such as [62] we can see how machine learning allowed to literally make new recommendations of potential future discoveries. Moreover, in [45] and [74] , further possible applications were introduced to facilitate the development and refinement of creative tools in design, recommendation systems, etc. All these applications suggest that AI is now being positioned as a human assistance tool and not only as an additional support resource[45]. Furthermore, new findings and upcoming releases are expected to upgrade AI's role and its maturity and complexity level, shifting from human assistance to a partner autonomous intelligence, [75]. This means, new systems will be able to leverage AI models to recreate and simulate creativity and support innovation.

Innovation can be understood and simplified employing a typical double diamond methodology of design.

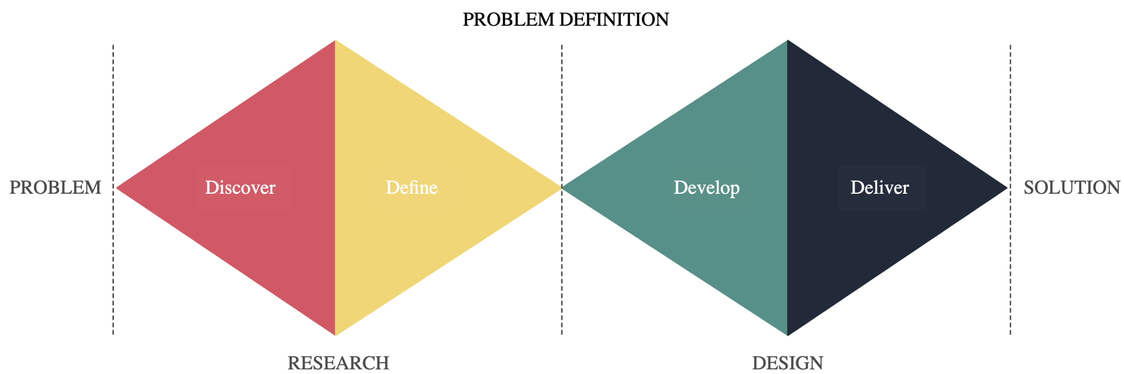


**Figure 15:** Double Diamond. Source: taken from: [76]

The double diamond shows a four step methodology divided into a domain of research or problem and a domain of solution or design, this model breaks the process of design creation into four categories: discover, decline, develop, deliver. We can also think of these steps as a convergent and divergent process, where we initiate opening a research and then we narrow down our possibilities, we start once more developing and prototyping divergently, and we finalize with a delivered or selected solution. This process of divergence and convergence fits pretty well within the definition of an algorithm, which is a procedure or sequence of steps used to solve a specific problem.

An example of this algorithm, can be seen using simple statistics for machine learning applications. Let's suppose we are trying to find the most common diseases of a population of patients. We then realize that diabetes is the number one in the rank, affecting about 35% of the total population, followed by heart diseases and prostatic cancer. The discovery process allows to open the scope of our search while the findings start scoping down the possibilities. Now we need a solution, we select diabetes. In this case, the discovery and define stages can be understood as mathematical sets of elements where we have an initial pool of elements and after a filtering stage we are left with a new set B that contains selected elements of A as it can be seen in Figure 16.

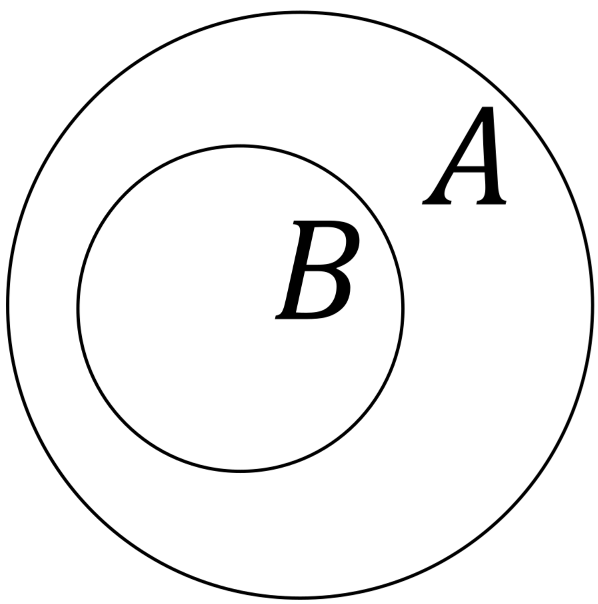


**Figure 16:** Sets A and B.

Having B, we are able to jump to the solution paradigm and start the design process. Based on our findings, we are able to construct, propose, assemble, or design a solution, i.e. to utilize the elements in B to find, expand and develop our solutions. What do have available to face diabetes? We start once more the divergent stage to fetch and come up with solutions. We start searching for names, brands and kinds of pills or substances to remediate the problem, the stage of exploration is re-engaged, we start finding alternatives for our needs. However, not all of them are available or feasible and some of the proposed treatments and solutions are still theoretical proposals, so the scouting process starts a filtering and discarding stage, a the definition stage where some options are eliminated and some others remain adequate and probably part of the solution.

This means we used the element or elements of B to extrapolate our search from the problem domain to the solution domain. Here, we can recollect the value proposition model where we have found a need or demand we require a solution, pain reliever, etcetera. We extrapolate and transpose the elements of B, i.e., diabetes for this example, to search for diabetes cure, treatments and medications. While 'diabetes' remains to be the pivotal concept, disease and cure, treatments and medications are the polar concepts. And so we link set B (diabetes disease) with set B'(diabetes cure). Conceptually and semantically, this can be understood again as an intersection of mathematical sets. Where the pivotal concepts intersect while the polarized concepts remain in their respective groups. In a simplified way, we can say that pivotal concepts underpin the discovery phase, while polarized and contextual concepts facilitate and allow to propose an actual set of solutions and possibilities.

Looking at the double diamond model we can infer that a single diamond is susceptible to be used as an algorithm, as a matter of fact, the mere definition of the scope of a problem is already solving part of problem. While the second diamond (the design domain) is much more related to the capacity to pose tentative innovative proposals.

The second diamond can be related to what we call nowadays, generative AI, which is capable of reproducing and creating content based on specific demands or queries and delivering prototypes adjusted to designer's commands. However, in real life, companies and organizations do not have a simple four-step process to generate solutions and implement products and projects.

A stereotypical innovation pipeline consists of a funnel that goes from ideation to launching or implementation. Naturally, each organization will have its own processes, an example of a general conception can be seen in 17. Let us briefly discuss the steps displayed in this funnel.

I) Ideation

In this stage it is expected to have a brainstorming session to raise insights, proposals and new conceptions about a need, problem, or necessity. Ideation can be regarded as the ignition innovation phase, where creativity and imagination step in to formulate alternatives.

II) Discovery

This is an exploratory phase where the ideas and proposals previously recollected are now employed as inputs to do a more concise search of solutions.

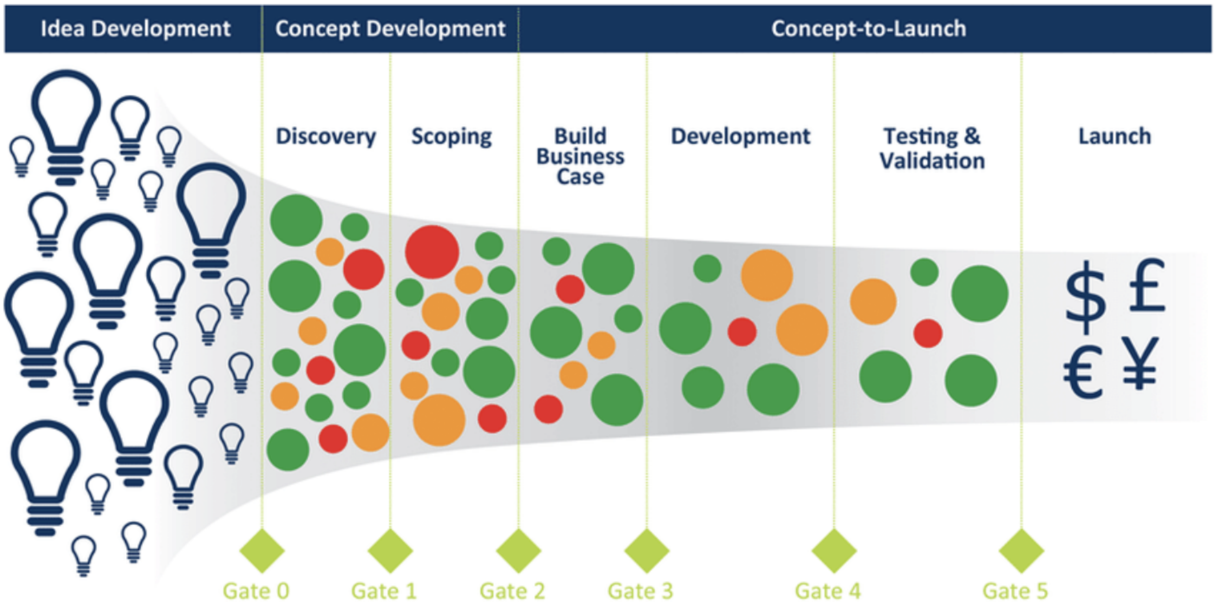


**Figure 17:** Innovation funnel. Taken from: [77]

Unlike ideation discovery is a step ahead in terms of concreteness and availability.

III) Scoping

This section allows to narrow down our solutions' search significantly and set clear boundaries, expectations, and capabilities. It outlines and frames the findings of ideas and discovery to visualize the limitations and potentialities of our endeavor.

IV) Building a business case

The development of a business case sets the stage for the execution of the solution, it reflects the feasibility of the development, and it summarizes the economic requirements and benefits. The business case also contains a value proposition that synthesizes the gain and value of the investment. The business case is also fundamental to understand the resources required for the next stages and it allows to evaluate the appropriateness and alignment of the development of the solution with the strategical objectives of the organization.

V) Development

In this stage the materialization or construction of the solutions takes place. This is where the labor is executed to move from idealization and discussion to actual functional products, services, deliverables, etc. Usually, this is the time when organizations create prototypes, proof of concepts, simulations, and other preliminary attempts to reach a final delivery.

VI) Testing and validation: During testing and validation, the expected and pre-determined functionalities and specifications designed for the solution are subjected to show the compliance with design standards and demands. Whether it is a product, service, or any other development, a validation is required before any deployment into production or commercialization.

VII) Launch

The final stage of the pipeline consists on the implementation of the solution, i.e. the release of the development in order to make it available and operational to the users or consumers.

Once again, this stereotypical pipeline is only a depiction of some of the most common stages of a linear waterfall innovation funnel; many other proposals are feasible to be integrated, such as agile. methodologies.

If we frame this innovation pipeline into our four diamond model we can see that the whole funnel is divided in sections, stages or steps, there's a starting point where we run the ideation phase and there's another point we kick off the actual development of a product, service, project, business, etc. This allows to fathom the innovation process as an algorithm of design, using for instance the double diamond model.

Encompassing the double diamond and the innovation pipeline we are able to distinguish a paradigm of problem-definition and another one of solution-design. In other words, we address the questions: what problem or need do we have? Circling back to the AI VP, we can relate it the demand domain, where there's an unresolved need, whereas the second domain, the value proposition shows us the offer domain, i.e, the spectrum of solutions we are able to come up with. These divergent and convergent cycles are a bridge to link AI tools such as machine learning algorithms into innovation management. There are countless current models and proposals of machine learning, natural language processing and from linear regressions to sophisticated generative AI (gen AI) models, not to mention the hype, trend and rapid utilization of chatbots and large language models. It is indisputable that the current AI state of the art applications are pervasive, impacting all sorts of technological uses, powerful in terms of practical applications for businesses, organizations and societies, and accelerating at an unprecedented speed. Nevertheless, SMEs do not move at the same pace and furthermore, they lack the capacity to implement complex, expensive and unexplored solutions. In simple words, small businesses are not mainly concerned about top notch technology releases but rather, micro-economic variables that will impact their products or services, and can jeopardize their capacity to cover the payroll, debts, taxes; Also, in countless countries such as Mexico, USA, Germany, Colombia, etc. SMEs remain the keystone of the economy, and the fundamental source of employment. Moreover, the mere introduction of new technologies imply a proper management of adoption, usually resulting in the necessity of new training for employees, review, analysis of processes, financial evaluation of the technology acquisition, among many other collateral effects that must not be understate in order to keep the survival of business. Additionally, the technical expertise required to implement AI-tech- solutions “among many others” is quite often beyond the capabilities of SMEs, many of these are still struggling to reach an incipient level of digitization into their regular administrative and operative labors. This technological gap between large technological companies and SMEs sets a competition boundary, and it may become an indirect shape of monopoly or oligopoly.

In order to foster the adoption of new technologies and expose a proposal to facilitate the comprehension and utilization of AI we propose the artificial intelligence innovation management assistant model (AIIA). This model is to be understood as raw material for organizations thar wish to implement AI into their own particular environments.**The model contains two additional elements that are indispensable building blocks for the development and implementation of any AI solution incorporation, 1) a supervision steering committee and a set of data inputs (cloud or on-premises)**.

Encompassing these two elements along with the innovation pipeline and the double diamond diagram we present the AIIA model in Figure 18.

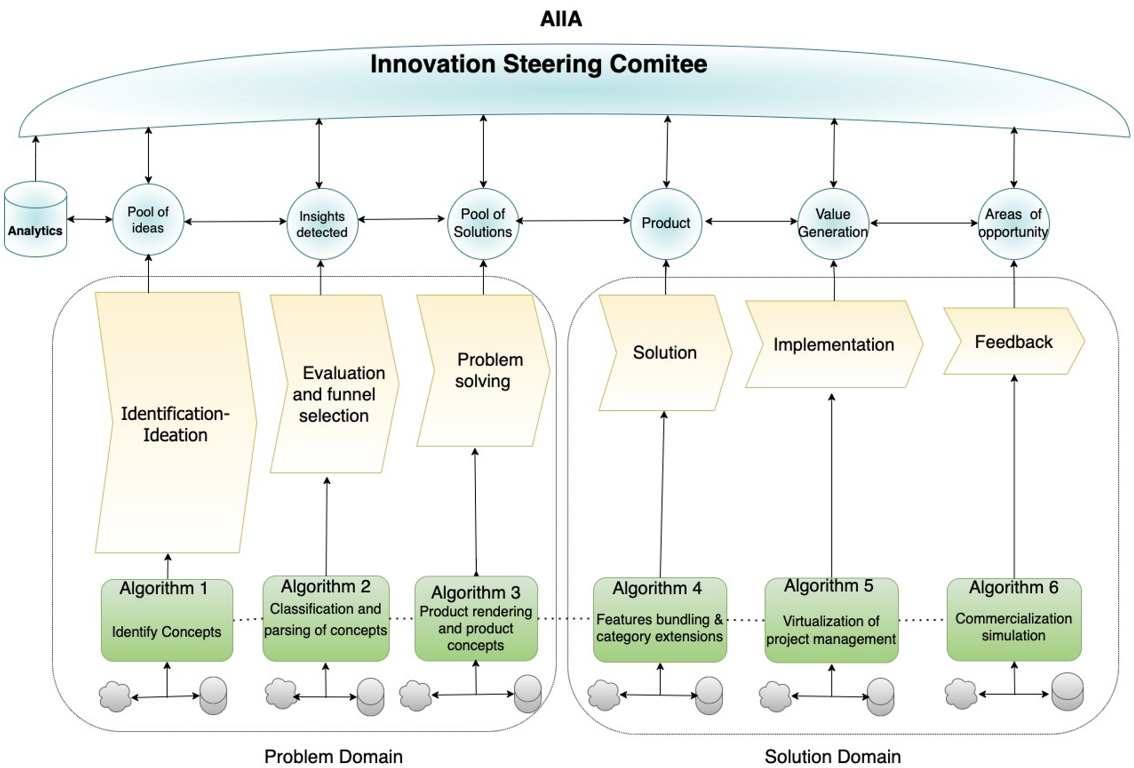


**Figure 18:** Artificial intelligence innovation assistant model

The AI model presented contains a set of six algorithms, each one of them is interconnected with the data and the innovation pipeline process. These algorithms represent the artificial intelligent aspect of the model, they operate simultaneously. Although the model is depicted in a linear waterfall fashion, and it is read from left to right and bottom to top, it is actually a system of systems, interconnected to provide feedback. All the algorithms operate and cooperate in parallel while at the same time they are interlaced to share information. Unlike a regular real timeline innovation process, the assistant is meant to virtualize the innovation processes to be able to assist all along. This means any change in the system alters the rest of the elements. For instance, the algorithm of product rendering and product concepts may alter the identification of concepts and simultaneously the commercialization simulation if it encounters that a given product concept is to be discarded. Similarly, the virtualization of project management can provide outputs to modify the identification of concepts or classification and parsing of concepts. In other words, the model works as a six-algorithm intelligence when all inputs and outs are simultaneously providing feedback, therefore the model can also be conceived as a circular and modular systemic innovation AI. However, for simplicity sake, the AIIA model and its explanation will be described in a sequential way.

AIIA model, as a system of systems, circumscribes all six algorithms to provide outputs and insights to the steering committee. Let's analyze each one of them in further detail.


**Figure 19:** Algorithms of AIIA

## 3.1 Identify concepts to obtain a pool of ideas

Concepts identification is a fundamental step for the ideation process. Employing NLP we are able to detect, label, and manipulate the key concepts that will form our pool of ideas. From our databases and especially from all the resources of big data that are now available, we are able to employ text mining techniques and other NLP skills to clean, tokenize, label, classify, ponder and arrange data to provide information about the core ideas that are available. Furthermore, we are capable to do a preliminary visualization of the most repeated or most relevant suggestions contained in a given text or file. A very simple and intuitive graphical approach is the well known cloud of words, where in a single image we can grasp a general idea of possible key concepts.

The goal of this algorithm is to discriminate words that are meaningful from those that are irrelevant.Currently there are powerful ways to process large texts to perform summaries and text mining analytics, and such tools are prone to be employed to facilitate this initial step. This detection of ideas and insights reduces the universe of proposals to a reduced and selected set of possibilities, facilitating the processing of all the rest of stages. Ideas identification is not limited to text, it can also be fetch in audio, images and all sorts of content that can be translated into human language and machine language. For instance, a database of fruit images can be employed to translate pictures into words and eventually bytes for the computer.

This algorithm takes into account not only a speech, text, or image processing; it can also incorporate generative capabilities to devise ideas or suggestions. This means algorithm 1 can be programmed to simulate creativity at this incipient stage. An easy example would be to employ the core concepts detected in a text to generate polar concepts or similar synonyms concepts to amplify the pool of ideas by semantic juxtaposition, polarization, or superposition. Ideation represents the most divergent modules af all, it widens the spectrum to consider proposals that might even sound illogical or unreal but that could attempt to mimic an "outside of the box thinking". In subsequent stages, all the proposals will be evaluated and included or discarded according to the development requirements.

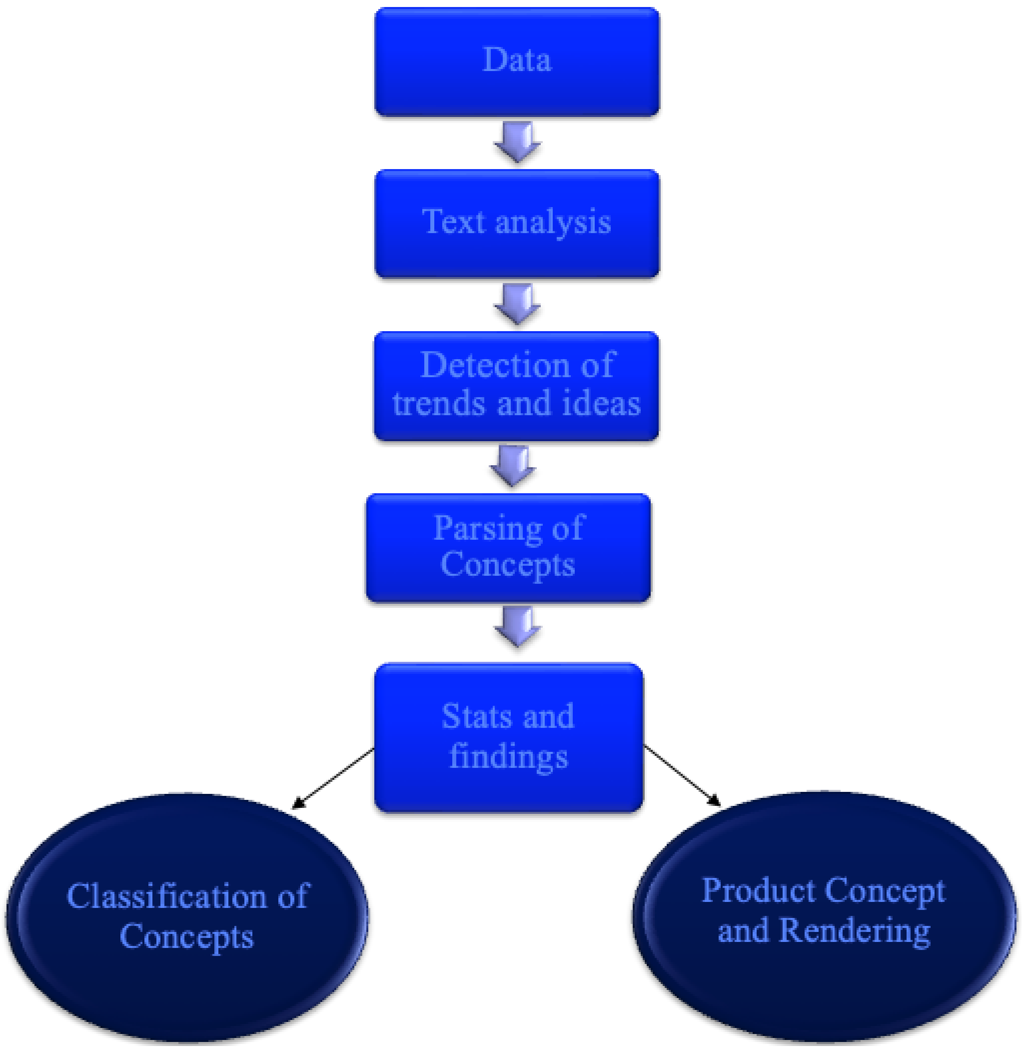


**Figure 20:** Implementation steps of conceptual processing algorithms

### 3.2 Classification and parsing of concepts

After the ideation pool is generated, an analysis of the information obtained is in order. Based on the requirements, we are able to evaluate and select those proposals that fit the best. Once more, this can be thought as an optimization process, where from a set of elements we must pull out the best ranked. Machine learning fundamentals can show us many intuitive examples, also, we can employ LLM to ask chatbots to support us in this is stage of the process. The parsing of concepts consists of a filtering and pondering of information (the pool of ideas) where we aim to decant the best ideas, this follows a waterfall mindset to simplify the understanding of the model. Another alternative to run this algorithm is to leverage words-embeddings to process and manipulate the concepts.

Thanks to its multiple applications to relate words semantics, it can perform a classifier of information. The ultimate goal of this stage is to sort out the information of phase 1, and prepare the information for the next stage. At this point we can recall our AI VP model, where the identification of needs, pains and gains is essential to satisfy the customers demands properly. Such identification requires a comprehensive analysis of parsing the concepts that synthesizes the customers demands. As a consequence, this stage is set up to grant a clear understanding of the necessities. For the model, an idea, problem statement, suggestion or proposal is essentially the same, those are all quantifiable possibilities (sentences) or potential candidates to be part of a solution and eventually become a product or service. Genetic algorithms are also another option to be taken into account to cooperate at this stage. Naturally, each organization based on its own knowledge, resources and capabilities is able to tweak and twist the model and the algorithms as required. The heuristics of the model will become vital for organizations to learn to implement their own adjusted algorithms. The characterization of a general solution will be defined in this stage. Therefore, the selection and supervision of concepts that will compose the insights detected cannot be understated. An idea or suggestion would be deemed as an insight as long as it is aligned with the core concepts that are reserved to express the core necessity to address, in Figure 20 we can see a generalization for the management of data and information that we can follow for algorithms 1 and 2.

This figure expresses a succinct example that we can follow to process the data to use it as inputs for the innovation process. This image also shows that within the AIIA model, several underlying processes are required to be executed to turn the initial data inputs into functional pieces of information. The text analysis or also text mining consists of a series of techniques that allow us to extract meaningful information that can preliminary reveal patterns or findings non-visible in an unstructured file. Also, during this analysis we can clean, label,discard, classify or cluster information that might not be needed, facilitating and lightening the computational processes of upcoming stages. This pre-processing stages of data will grant the elementary blocks of information to form the main trends and core ideas found in the text that align with our innovation process. Ultimately the aim is to dissect the text to spot the core concepts that circumscribe the key messages of the texts. Conversely, the residual information that does not belong add meaningful information is to be discarded. Nevertheless withholding this information as secondary ideas or contextual information can be helpful if we are running exercises, algorithms, or processes where complementary words are needed.

The final product is a distilled set of information that characterizes the essence of the documents' insights. All this processes must not be misunderstood by comparing it to a simple summary; while the summary contains a reduced version of the document containing core ideas and expressions, the pre-processing of data, the text analysis, detection of trends and ideas and the parsing of concepts must be align to the our innovation inquiries. As a consequence, the text may have several relevant contributions but if those are not part of our research object, they might be disregarded.

At last, the statistics and finding are the mathematical and linguistic representations and outputs that reveal the purpose of the whole data examination. There are uncounted methods of statistical representation that can assist to display and model the outputs.For instance,a simple gaussian distribution can be implemented to show the typical and atypical words found in a set of documents and allowing to derived applications for topic classification or semantic correlation[61]. Products, services and all sorts of goods that are produced and consumed are initially compose as a series of concepts that configure a tangible or intangible value, i.e., ideas, products, business, services, etc. are, at a fundamental level, conceive via thoughts which are ultimately realize by words. This means, the process of ideation, creation, and all the steps that are found trough the innovation life cycles and stages rely on the sobering fact that the articulation of words and concepts express by consumers and customer matches the formulation of words and concepts integrated by developers and producers in the formation of their goods and services. Therefore, this first stage of the AIIA model that includes the problem domain diamond relies on the premise that conceptualization is the keystone of innovation and creativity, and if it is to be mimicked by an AI system, such a system must be able to parse concepts to formulate and imitate (at least up to a certain degree) thought processes of innovation, one of them being categorization or classification of new or unexplored ideas to find the best candidates for a problem or need. As a result, an AI system at this stage, is an intelligent discriminator of information and conclusively an artificial intelligent selector.

### 3.3 Product Rendering and Product Concepts

The last stage of the first domain of AIIA model consists of an algorithm to diversify and subsequently refine a set of possible solutions for the problem domain, i.e., an amplification of potential solutions and a discrimination of these, to be left, once more, with a refined pool of solutions. This information decantation process is leveraged by many examples nowadays in AI. Generative models do offer a wide range of possibilities to create content variations using baseline inputs such as words, sketches, speeches, and twist-ing it to shape alternatives. In Figure 21, we can see some applications of the generative AI use cases. In this figure, there are three main areas of potential applications: language, visual and auditory content. For the algorithmic structure of AIIA, the conceptual and language applications are particularly helpful.

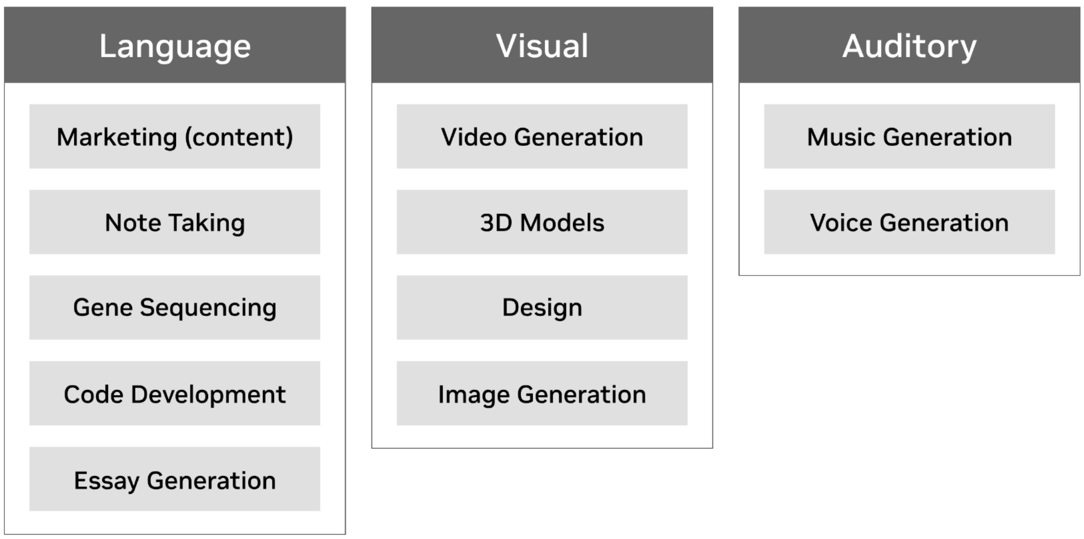


**Figure 21:** Generative AI use cases.Taken from: [78]

This algorithm takes into account a baseline for the development of multiple series of sketches for the diversification of an initial model. Take, for instance, the example of a drawing, where you keep a set of basic elements of the body such as, core, head, extremities, etc. and you replace, alternate and modify the rest. The elements that are to be kept represent the elements of the solution that are fixed while the modifications and variations of the solutions will be applied to the variables of the solution. In summary, this algorithm allows to render solutions via a series of combinations between constant or fixed elements(infrastructure) and variables (superstructure). Naturally, it is also possible to create not only one set of fixed elements and one set variable elements and play with them but to have multiple sets of fixed and variables elements, allowing also to have permutations. In this stage of the AIIA system we go from conceptual insights to rendered solutions, this means the insights detected now operate as the main conceptual inputs and references to display a concrete output for the pool of solutions. Today, in generative AI applications we can see that this use case is thoroughly exploited in AI design software to generate visual content. See an example in Figure 22.

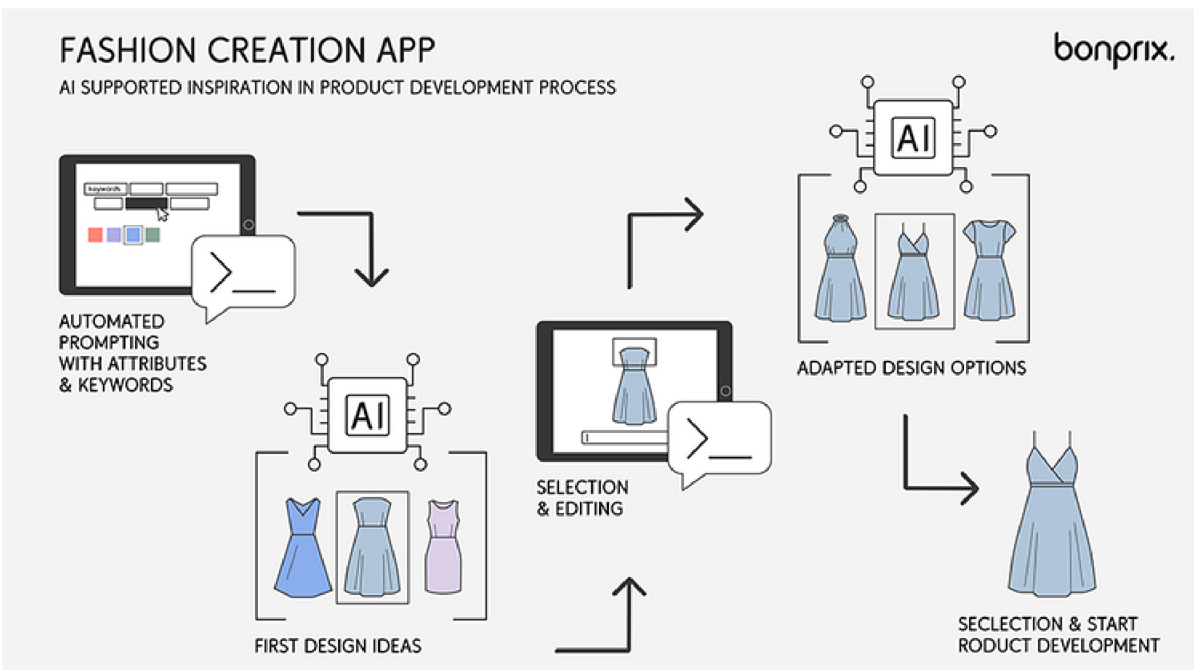


**Figure 22:** Design with generative AI, fashion creation app. Source: taken from: [79]

This kind of application is quite advantageous to facilitate the creation of samples to exhibit abstract concepts into visual outcomes. Another depiction of the multiplicity of options provided by this algorithm is showed in Figure 23, where there are many "manufacturable options" during an initial iteration phase, prior to the creation of a product. This is precisely the last step in the AIIA model of the problem domain, the output of a pool of solutions, however, unlike the generative design suggested in this image, we are not yet moving to the design production immediately; we are still going to run another algorithm to choose a unique solution or a few selected solutions.

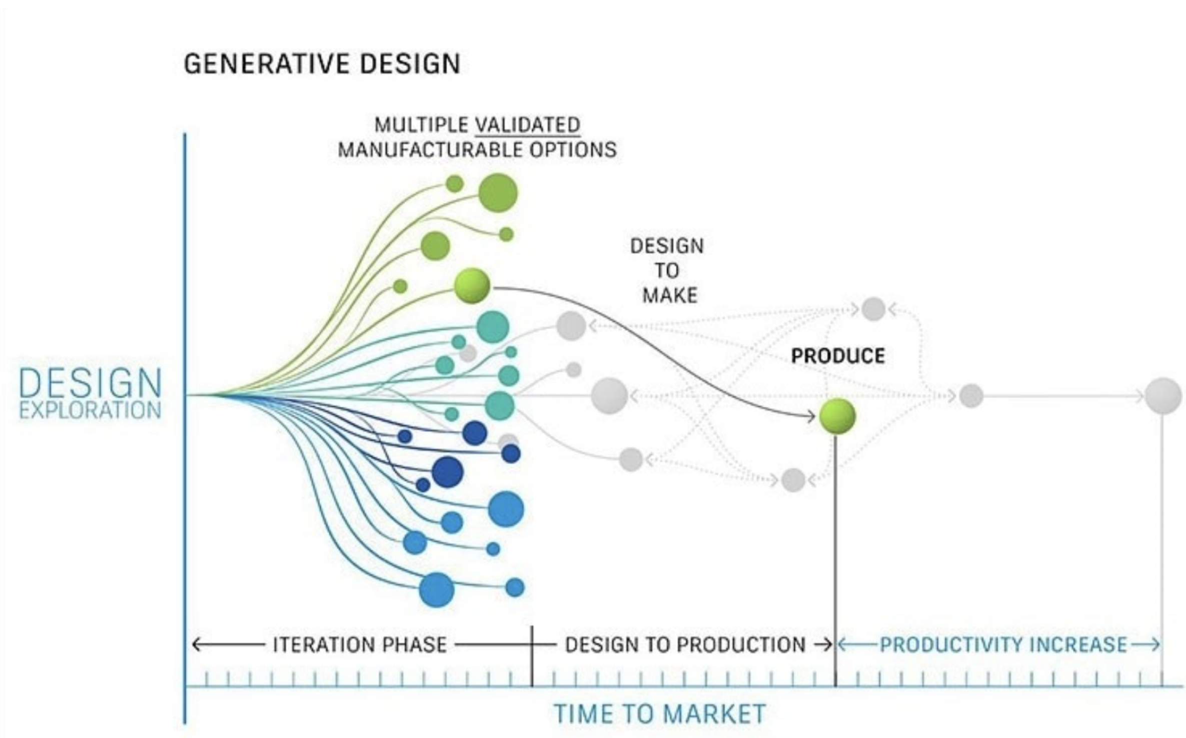


**Figure 23:** Generative design. Taken from: [80]

### 3.4 Features bundling and category extensions

This is the first algorithm that belongs to the solution domain, leveraging the pool of solutions, we take all the inputs gathered in the previous stages to run a cross-section and integration of product-service features and the modification and adjustment of product variables into categories. This algorithm serves as a refinement selection process for AIIA. We seek to consolidate the top ranked or best fitted features of several products from the pool of solutions and arrange them into a single solution, allowing also to manipulate the specifications of those features and enabling the solution to contain -if needed- ad hoc categories that may transform an essential characteristic or functioning of the product. Combination of categories may also imply a new but also "unreal" combination of features; for instance, A)Solution 1: a red car that uses a clean energy motor and B) Solution 2: a green airplane that travels at the speed of sound. Both of these product-solutions may be turn into: a car that uses clean energy to fly at the speed of sound. This new concatenation of features also implies the decomposition of conceptual categories to recombine them, in this example, a car may not be categorized as a flying object, and as such a flying car will extend the core concept of a car to consider it -at least tentatively- a flying vehicle.

Similarly, we can compose a product by recombining the concepts differently, e.g.: a red airplane that uses a clean energy motor to travel at the speed of sound. These features combinations are also widely used in content generation, for the generation of images, videos, etc. see for instance Figure 24. We can also understand the essential or core features of a product as a latent space that will eventually allow us to produce a massive set of possibilities, variations, or fluctuations. In generative AI models, noise is introduced as input to alter features and create this sort of variations.

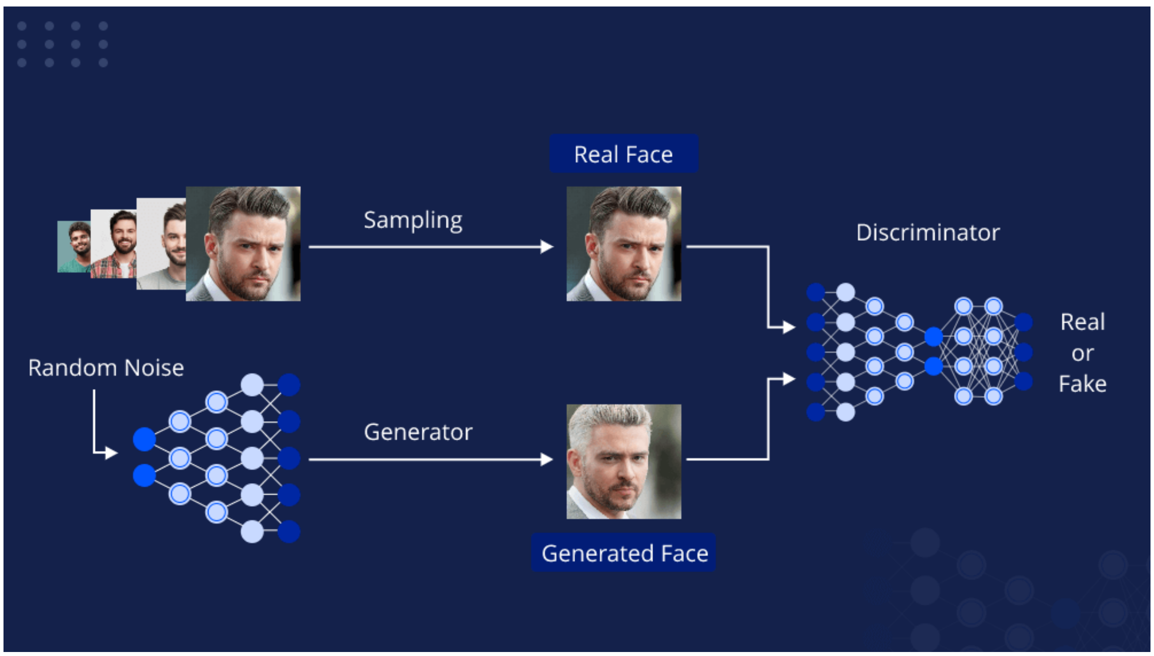


**Figure 24:** Generative AI design model. Source: taken from: [81]

The extension of categories may also be understood as an extrapolation or interpolation of a product or service into a different business model, market, or alternative product or service purpose. In simple words, if we modify the context of a word or concept, we may be -by default- altering the meaning of the concept, for instance: the concept "wheel" may have very different meanings depending on its context. Nowadays, several tools of NLP offer a wide range of options to manipulate concepts to generate "artificial creativity", large language models and bots can also be employed to facilitate the extension of categories, however, one of the key limitations of many of these LLMs is the -generic nature of their answers-, in these scenarios small language models may play a more important role to serve as interpreter of concepts and ideas for the AI language processing. In Figure 25 we can see a comparison between LLM and SLM. Another way to understand this algorithm is to define it as a refinement stage after getting a pool of solutions, the refinement process emphasizes two aspects: A) the integration and arrangement of features and the modification of the categorical context of the solution. Current applications of Generative AI employ a few prompts to create content, this is another great example of how a few concepts are able to underpin or at least to aid the conception of a creative object (whether product, service, etc). via the use of the core words that reflect its meaning. When required this prompts are susceptible to be rearraged to generate numerous alternatives (as described in the pool of solutions, but ultimately all these alternatives can be introduced to merge the desired or best features of all them into a single deliverable, in the case of this AIIA model, the word product is this deliverable, and it is to be understood as outcome describing the solution, which may be a service, a tangible or intangible product, a value proposition, etc. The terminology product for AIIA is not limited to a tangible manufactured object.

The categorical extensions also allow to widen the scope of the solution. This combination of features can incorporate subroutines of other algorithms such as: "genetic algorithms ", the bundling of features and the categorical extensions are meant to provide the optimal solutions utilizing as inputs the put of solutions, this is why subroutines are expected to facilitate the acquisition of the final outcome, i.e. the product.

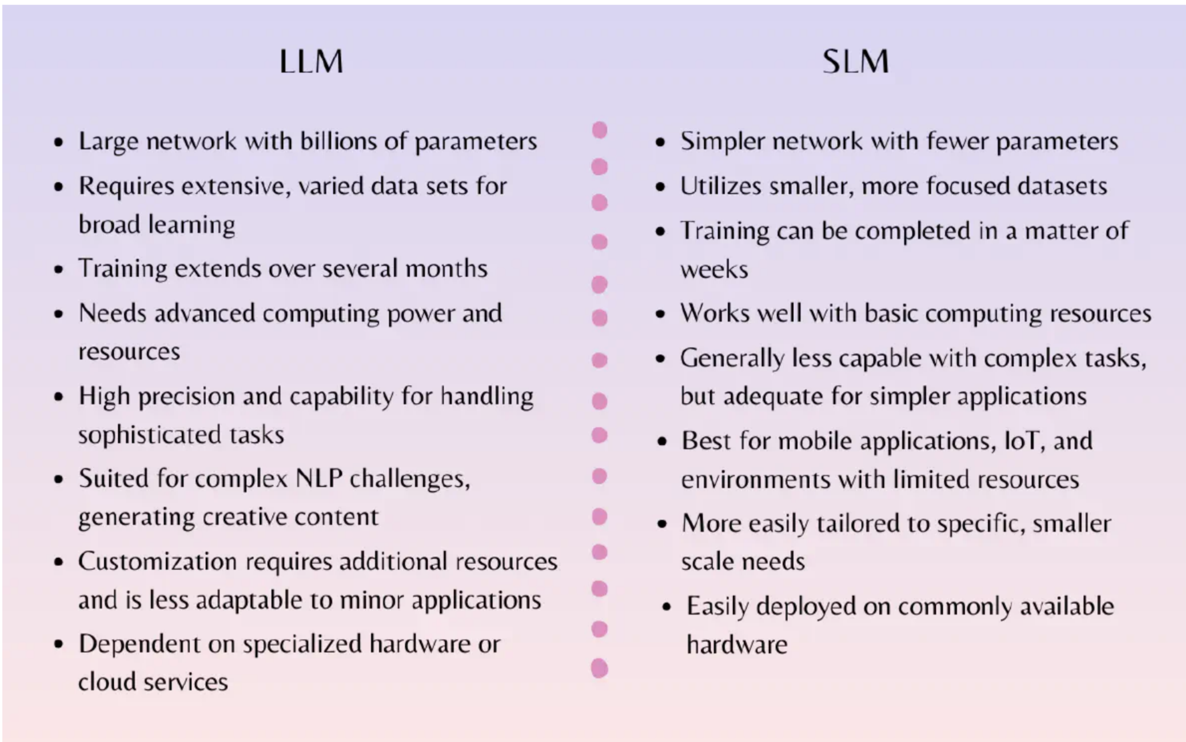


**Figure 25:** Large language models vs small language models. Source: taken from: [82]

## 3.5 Project Management Virtualization

The virtualization of project management is proposed as an algorithm to visualize and preview the solution executed and implemented in a tentatively real scenario, i.e. this algorithm is a simulation of variables to create a landscape of the solution's introduction into an actual environment in the world.

At this point, it becomes extremely important to consider the scope of the product within a project. Understanding what environmental factors and variables are going to be tested and considered within this virtualization is essential. Naturally, a fuzzy or unclear scope for the product and then, as a consequence, a vague scope for the project will undermine the ability to develop a helpful simulation. Furthermore, it is indispensable to have all the data available to turn the features of the product or service into actionable projects for the project simulation, for instance: the proposal solution of a product will pose a cost that is going to be one important element of the project simulation. This element can be pondered against a dataset of similar products or services, and it can also be compared and analyzed within a given market segment in order to judge the variable of cost within a real-world simulation. For example, if we employ neural networks within this analysis, we can consider the variable cost as one of the numerous inputs of the network; in this case, the cost will function as a single variable that will be ingested within the network along with a series of other variables.

The virtualization of project management would require a very comprehensive dataset to be able to provide meaningful insights. However, there is also room for much simpler implementations, where it is possible to simulate only certain stereotypical variables of projects' development. The simulation of a project, at least at an initial and preliminary, will have to set clear a clear and define scope, some of the main variables of the project definition and a structured delivery may simplify the development of the project.

Each simulated scenario may require a significant effort and even a profound investigation inside the organization to be able to compound the databases to produce a virtual segment of the project. For instance, if we consider a waterfall structure for a project with clearly defined milestones and deliverables, even the simple simulation of the development of the first milestone requires a dedicated analysis, however, pilot tests and prototypes of this kind of projects or at least segments of the project can provide a foundation for more complex endeavors. Projects such as packages delivery forecasts and their interaction or dependency on subsequent tasks are suitable and "simple" enough to start creating knowledge, heuristics, needs, requirements etc. to foster the bases for an AI assisted innovation management environment. As a consequence, this algorithm is actually meant to enclose a vast and sometimes complex series of steps.

Nowadays, state of the art allows to set the stage for implementations such as process mining that can be plugged into the systemic processing of models like AIIA. In this type of mining, events logs become quite relevant, they contain information of the behavior of a given process, and just like they are capable of detecting bottlenecks and deficiencies in processes, they can also be applied to run simulate scenarios that take place when executing a project, providing forecasts, and an expected or common behavior of a set of actors and variables within processes that sustain a larger outcome. Process mining may also be able to serve as first notch to teach an AI system to understand how activities within a project and within a process are connected and related. Project and innovation managers as well as engineers are expected to understand the particular needs of a project and study the AI tools that are best fitted.

There is a wide range and an extremely large scope of possibilities to recreate project simulation scenarios, one of the characteristics of the definition of a project is its singularity, as a consequence, the virtualization of a project is ultimately a forecast of a series of variables and their expected behavior cooperating as a system. Enabling the analysts to get knowledge of the typical or atypical conditions that a given project may experience based on the recollected data.

The output of this virtualization is meant to reflect the value generation of the project's implementation, this value generation can be presented in the shape of performance indicators, financial ratios, cases resolution, problem correction, pain mitigation, etc. Lastly, the project management virtualization conceives and accepts that a project is an enterprise or endeavor undertaken to achieve an specific goal or objective in order to satisfy a need or obtain a benefit; this broad scope allows the project management virtualization to embrace countless types and variations of simulations, and it allows different sorts of innovations to be integrated and included into the systemic analysis of AIIA.

### 3.6 Commercialization simulation

The last algorithm -commercialization simulation- has a particular focus on the behavior of financial, economic and commercial variables. It can be thought of a direct extrapolation of the predicted value generation outcome. This simulation is also an important feedback for the rest of the input-output systemic network of AIIA, since it contains the result of whole process in terms of technical feasibility and financial profitability. Under certain circumstances this simulation could be embedded as part of the project management virtualization, the commercialization may be considered a part of the project and its related financial variables; however, this increases even more the complexity of a single algorithm that is already containing an enormous number of parameters to estimate and adjust.

Unlike any of the previous algorithms, this one is meant to contain the variables that are actually going to be delivering the financial results to the organization, providing as an output feedback about the business objectives. This algorithm is particularly focused on contrasting and evaluating whether the value delivered to the customers and users is actually aligned with the strategic objectives of the organization and the profitability expectations; furthermore, the commercialization allows to review an end-to-end process of innovation, because it reflects whether all the previous stages are sustainable from a marketing and economic standpoint. This is crucial in the evaluation of AIIA, ultimately the assistance of a virtual intelligent system must be set to ponder the alignment of the innovation project and the organizational objectives of the company, i.e., AIIA within this algorithm must be able to contemplate the traceability of the project at hand and the overall organizational objectives.

## Partial Model Application Simulation

In order to represent this model we are able to come up with a minimalist mathematical model that would allow us to understand the connections of the algorithms as an interconnected system. For this instance, we propose an approximation of AIIA employing a linear combination:

$$M = |w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 + w_5x_5 + w_6x_6 + b| \tag{10}$$

This equation reflects a linear combination of six pondered variables, each one of them representing the output of the algorithms that are coalesced in the AIIA model, including a factor of bias (b).

The math modeling core of AIIA consists of the implementation of the following steps:

1) Identify
2) Ponder
3) Diversify
4) Converge
5) Apply
6) Predict

The modeling of each algorithm and its mathematical representation requires a full study that actually assembles the intricate and robust environmental conditions for a successful characterization; also, according to the literature review presented, the implementation of the model is beyond the state of the art in terms of technology development, but it does provide a framework of innovation management purposes, which aligns with this investigation research. Nevertheless, we present a prototypical and theoretical simulation to depict the potential uses and implementation of the model. We're limiting the current simulation only to the single algorithm section of ideas or concepts categorization.

Variable 1, represented by vector $x$ with its respective weight $w$ with a which encompasses the generation of ideas, is proposed to be represented as a set of values that are identified, classified, and pondered according to its repetition or frequency (possibly showing a likelihood of a tendency) as proposed in [81] from multiple options as described in [61] for words and topics selection and processing.

$$M_{a1} = |w_1 x_1| \tag{11}$$

Now, we display a set of concepts and their respective random values in three data columns. These random values are proposed only for simulation purposes and represent the pondered value or weight of a given concept $C_n$ within a corpus.

Table 1: List of values

| Idea number | Weight-corpus 1 | Weight-corpus 2 | Weight-corpus 3 |
|---|---|---|---|
| $C_1$ | .0044 | .0058 | .076 |
| $C_2$ | .0059 | .0079 | .0248 |
| $C_3$ | .0071 | .037 | .008 |
| $C_4$ | .0084 | .0051 | .012 |
| $C_5$ | .0081 | .088 | .016 |
| $C_6$ | .0044 | .0058 | .76 |
| $C_7$ | .0059 | .0079 | .0248 |
| $C_8$ | .0071 | .037 | .008 |
| $C_9$ | .0084 | .0051 | .012 |
| $C_{10}$ | .0081 | .088 | .016 |

For this simulation a set of assumptions and annotations are in order:

I) The frequency or repetition of a given word actually represents its pondered relevance.

II) The low frequency or repetition of a word disregards its relevance.

III) The high frequency or repetition of a word typifies a trend or a core idea.

Words which are highly repeated but are not described as concepts, such as stop words, connective words, etcetera, are meant to be disregarded.

IV)Proper text preparation or data cleaning is usually required to process the words and concepts for analysis.

V)Identification of key words and concepts may involve data mining techniques that are not described in detail in this simulation. Nevertheless, the identification of key concepts is recommended to be expanded beyond their frequency values(weights), since it is not the only relevant metric to evaluate and ponder the concepts.

Datasets are loaded and vectorized. Therefore, we define:

$$I := w \sum_{a=1}^{s} \sum_{b=1}^{m} \sum_{c=1}^{n} A_{smn} \tag{12}$$

where:

$I$: is the total pondered number of inputs or items within the data-set.

$s$: is the total number of data-sets available for the analysis.

$m$: represents any of the columns of the the data-sets.

$n$: represents any of the raws of the data-sets.

$w_{smn}$: represents the weight to be adjusted(if needed) for optimization or fine tuning.

In simple words, $I$ gives a preliminary insight on the total weight of the $10$ selected concepts, i.e., it shows, within a single value, the summation of the average selected concepts. This may be particularly useful when comparing two different sets of corpuses, and when the human capital, technical expertise or resources are limited to do a much more robust and comprehensive analysis.

Based on the output of $I$ can determine whether this first quick indicator shows an average value to consider the corpuses as subject of interest with respect to the selected concepts $C_1 ... C_{10} ... C_n$. Although this first text analysis can easily be done via a current large language model, or similar AI chat. The intention of this parameter is not to outperform in any way the current state of the art techniques for text mining or analysis, but to display in a simple manner the elemental steps that connect an incipient text processing algorithm within the innovation management process. Regardless of the level of sophistication of the text or conceptual analysis, the methodological understanding becomes an essential part of the knowledge-episteme which is proposed and studied in this research. Furthermore, for simplicity sake, we have limited the current analysis to the average weight of words without their respective respective weights standard deviation or variance previously proposed.

Now, we set a filter to emulate the classification of ideas based on priority or selection, a minimal selection would divide or tag the terms in 2 sections as is displayed in the following equation:

$$f(x) = \begin{cases} 0, & \text{if } x \leq w \\ 1, & \text{otherwise} \end{cases} \tag{13}$$

Where $w$ sets the boundary of acceptance for the concepts. We propose a $w = .005$ to filter the data. The determination and fine tuning of this parameter is essential for the learning process of this algorithm. This parameter may be optimized using a particular AI or machine learning technique.

As a result, we obtain:

Table 2: List of filtered values

| Idea number | Weight-corpus 1 | Weight-corpus 2 | Weight-corpus 3 |
|---|---|---|---|
| $C_1$ | 0 | 1 | 1 |
| $C_2$ | 1 | 1 | 1 |
| $C_3$ | 1 | 1 | 1 |
| $C_4$ | 1 | 1 | 1 |
| $C_5$ | 1 | 1 | 1 |
| $C_6$ | 0 | 1 | 1 |
| $C_7$ | 1 | 1 | 1 |
| $C_8$ | 1 | 0 | 1 |
| $C_9$ | 1 | 1 | 1 |
| $C_{10}$ | 1 | 1 | 1 |

This table reflects succinctly whether the selected concepts have a pondered relevance based on the selection of concepts and the value $w$. Once more, $w$ or similar optimization and weight parameters are meant to be adjustment during a regular dataset training session.

Now, we employ an actual use case for a classification application of medical devices descriptions.

There were two datasets utilized in this work: Dataset A obtained from[83] and Dataset B, author's property and derived from manipulation of Dataset A. Dataset A contained a list of 314,714 text strings (medical descriptions), each of these containing a set of medical device concepts; however, these strings did not represent a robust description of the medical device, on the contrary, only a few (2-5) words were provided as generic descriptions of the device. In addition, each column contained a risk-classification of the medical device. The following steps were taken to clean the Dataset A: stammering, tokenization, non-stop words removal: Unlike narrative texts, medical devices require ad hoc expertise inspection. Terms such as x (x rays), k (potasium), DC (direct current) are meant to be kept and understood for the analysis. Finally, we have "uncapitalization", in order to obtain a full lower-case list of strings. This cleaned version could be considered as data set A.1. A summary of the work done in dataset A and B is depicted in figure 26.

As a next step, manual tagging was employed in order to employ a support vector machine technique (SVM). A list of 459 medical device descriptions was reviewed and tagged with a classification value of I, II, or III. This evaluation was consulted using the pre-existing evaluation of US FDA. Although the device classification is threefold, the real challenge emerges between classes I and II. The risk distance between classes I and III allows the model to make

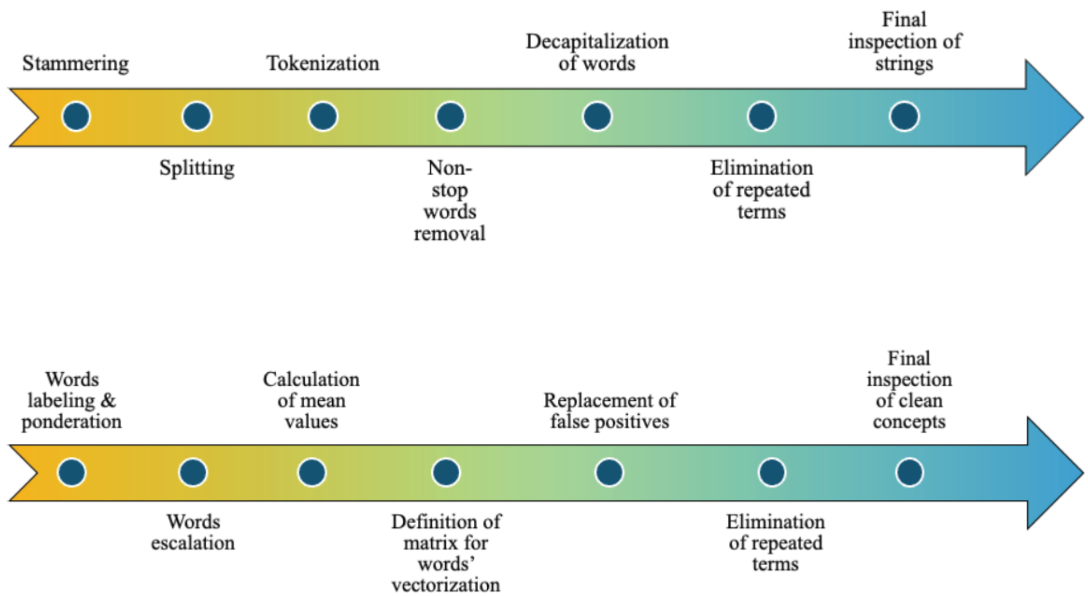


**Figure 26:** Words preparation steps.

accurate predictions, while the proximity of classes I and II makes a much more complicated scenario; this is why it was selected to employ SVM.

$$Y(m) = \left\{ \begin{array}{ll} 1, & \text{if } \ 0 \leq m \leq t_1 \\ 2, & \text{if } \ t_1 < m \leq t_2 \\ 3, & \text{if } \ t_2 < m \leq t_3 \end{array} \right\} \tag{14}$$

As a result, we get the distribution of the tagged words.

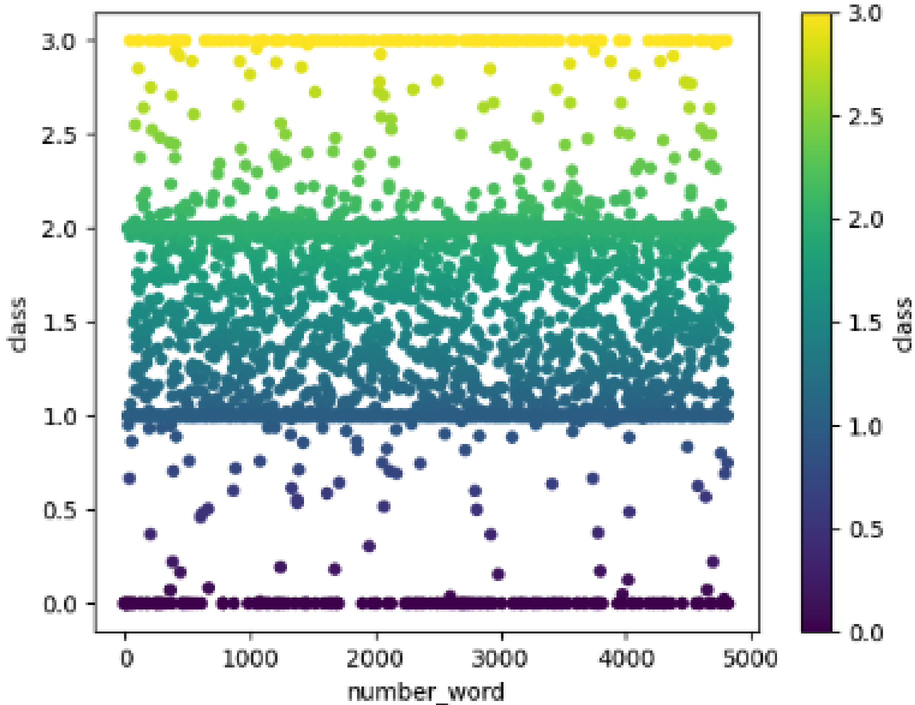


**Figure 27:** Words' tagging.

Applying SVM:

$$f(x) = \begin{cases} if \quad y = +1, \quad wx - b \geq +1 \\ if \quad y = -1, \quad wx - b \geq -1 \end{cases} \tag{15}$$

As a result, we get the following sample of devices' classification:

Table 3: Classification results

| Device | Device ID | Predicted Value | Real Value | FDA-CLASS |
|---|---|---|---|---|
| Tongue Depressor | 430 | -1 | -1 | 1 |
| Elastic Bandage | 431 | -1 | -1 | 1 |
| Manual Wheelchair | 432 | -1 | -1 | 1 |
| Bandage Scissors | 433 | -1 | -1 | 1 |
| Thermometer | 434 | -1 | 1 | 2 |
| Syringe | 435 | 1 | 1 | 2 |
| Stethoscope - Electronic | 436 | 1 | 1 | 2 |
| Gloves | 437 | -1 | -1 | 1 |
| Cotton Balls | 438 | -1 | -1 | 1 |
| Fingertip Pulse Oximeter | 439 | -1 | -1 | 1 |
| Infusion Pump | 440 | 1 | 1 | 2 |
| Defibrillator | 441 | -1 | 1 | 2 |
| Electrocardiogram (ECG) | 442 | 1 | 1 | 2 |
| Blood Pressure Cuff | 443 | -1 | 1 | 2 |
| Portable Ultrasound | 444 | 1 | 1 | 2 |
| Insulin Pump | 445 | 1 | 1 | 2 |
| Nebulizer | 446 | -1 | 1 | 2 |
| Hearing Aid | 447 | -1 | -1 | 1 |
| Therapeutic Bed | 448 | -1 | 1 | 2 |
| X-ray Machine | 449 | 1 | 1 | 2 |
| Pacemaker | 450 | 1 | 1 | 3 |
| Artificial Heart | 451 | 1 | 1 | 3 |
| Implantable Cardioverter Defibrillator | 452 | 1 | 1 | 3 |
| Total Hip Replacement | 453 | 1 | 1 | 3 |

From the core concepts detected and from the overall pool of concepts, we are able to yield and enunciate a basic or prototype product concept.

Semantics are created containing preexisting ideas or concepts that can be reorganized or reshaped to create new meanings. Therefore, a given concept can be said to contain within itself an infinite subset of concepts that in conjunction create new meanings.

If we take for instance a simple document where we are employing text mining and within the document we find the word 'love' we take this input as '1', stating its existence(being) and the "full" awareness of this concept; in other words, we disregard whatever adjacent concepts may co-create the meaning of the concept "love". We simply acknowledge its singular existence. However, in the human psyche, the concept itself may evoke a very large and undefined number of sub-concepts or related concepts (co-concepts), in this proposal each of them may be represented by an integral in a multivariate n-dimensional Gaussian distribution. Therefore, we are stating that the whole accumulation of these sub-concepts forms or conforms a singular concept. In this work's suggestion we identify this concept as 1 and the lack of it as 0, when handling discrete data, we employ a finite summation; the actual application of this proposition is left for future research.

As an additional contribution to this exercise we display a set of key performance indicators (KPIS) found in [84], which can be employed for the current use case simulation.

$$M_{inn} = P_{pi} - P_{pa} \tag{16}$$

Where:

$M_{inn}$ is the financial margin due to the innovation released. $P_{pi}$ is the price of the innovation product. $P_{pa}$ is the price of the earlier version of the product.

Also for this evaluation and as part of a forecasting exercise we present the following KPI employing an indicator function:

$$1_{[0,\alpha]}(t-x) = \begin{cases} 1, & \text{if } (t-x) \in [0,\alpha] \\ 0, & \text{otherwise} \end{cases} \tag{17}$$

Where:

$\alpha$ is the lifespan of a given product or service introduction in the market.

$t$ is time.

$x$ represents the given independent value(s).

As a consequence, we establish:

$$\Omega_t = \int_0^\infty L_r 1_{[0,\alpha]}(t-x) \tag{18}$$

where:

$L_1$ is a given linear regression.

Such an expression turns into a convolution function, therefore:

$$\Omega_t = H \int_{t-\alpha}^{t} L_r dx \tag{19}$$

where:

$H$ is a given market size value represented by a constant value.

Following up on the sequential pipeline display in AIIA, after the product classification, we can now come up with a pool of product generation ideas and evaluate them based on KPIS.

## Discussion of Results and Limitations

AI is spreading rapidly and widely throughout numberless companies with diverse technological applications. The implementation of AI requires multidisciplinary support and crafted use cases where the organization is able to start off a new journey of artificial assisted activities. The literature review, validation process and the analysis of field data, confirms the necessity to include management practices to incorporate AI into the organizations, not only as a new technological set of tools but as a potential disruptive contributor, capable of assisting and co-working with humans.

There's still vast discussion on AI's ability return investment and optimize activities, nonetheless, the introduction of AI as a game changer for state-of-the-art techniques and for innovation is now a reality. The end of the pandemic unleashed an ongoing and accelerated delivery of AI proposals for smarts systems, large language models, automated devices, enhanced digital software, etc. that included in one way or another, brand new implementations of artificial intelligence. All these technological introductions are to be managed and regulated in order to maintain a real benefit for societies and organizations, i.e., misuse or poorly regulated policies may lead to dysfunctional AI use cases where the cost of implementing new technologies may surpass the benefit received. In addition, the model proposed a preliminary incipient platform for innovation managers and project managers. It is worth recalling that organizations are social phenomena and as such, they cannot be brought into a laboratory of experiments under systemic, replicable, and controlled circumstances to provide evidence of replicated and accurate results. Nevertheless, the methodology used and the solution methodology proved to provide statistical tendencies, qualitative and quantitative evidence, which can be summarized in the following points:

1) There is no general consensus about the current magnitude and impact of artificial intelligence within organizations seeking to implement it. However, there is an overwhelming tendency to claim that AI is, in fact, modifying standard techniques and processes to do innovation and innovation management.

2) The key and core elements as well as the dynamics of the AIIA proved to be useful in terms of simplicity, adjustment, or fitting to standard and legacy innovation management practices and technologies.

3) The current graphical representation of the model displays a waterfall dynamic, which fails to provide a systemic view of the model. Although the model is articulated and expected to be understood as a circular, holistic and feedback system, the depiction of the model conveys sequential and gate phased distribution.

4) The developed model has the potential to serve as a baseline platform to stimulate the insertion, investigation, and adoption of artificial intelligence tools. However, human intervention and supervision are indispensable throughout the creative and innovation pipeline. This also demonstrates that the inclusion of a steering committee within the model remains vital.

5) At the current state of the art, artificial innovation management still requires significant "regionalization", customization, and adaptation to incorporate AI tools into real business cases, product and service development, as well as business model development. In other words, AI still requires a lot of effort when it comes to specific and particular organizational processes. This means that while generic applications such as chat-bots and content generative tools are widely used, they lack the ability to provide value for specific ad hoc use cases.

6) The conception of innovation as a set of two different domains, depicted in the double diamond creative process conceptions, remains to be inconclusive.

Artificial intelligence assistance will shift the way innovation management processes are handled by introducing alternative practices to manage data and information to articulate value propositions for businesses and firms. While new tools and AI assistance are being effectively integrated into the innovation management practices, its adoption remains vague, generic, or superficial. In its current state, AI Innovation management has not radically changed the standard management practices employed across organizations, but is modifying its processes. The inclusion of artificial intelligence will require a new conception of the systematic articulation and conception of innovation in organizations that wish to include such tools. The research performed showed that while a new conception of systematic articulation is required to incorporate AI into the innovation management practices; while managers may not be required to become AI experts, an overall understanding of the tools is required to be able to integrate multidisciplinary teams across the organizations to manage AI into the processes. Currently, artificial intelligence does not have the capacity to replace human creativity, its inclusion in innovation management practices will be limited to assist activities and facilitate processes. Generative AI is replacing basic and elemental human functions that can be considered as part of the creative process, but it lacks the capacity to fully replace humans for the end to end process. Also, it is still unclear whether AI itself may be called creative, while the philosophical and semantical discussion is out of the scope of the current research, it does not disregard its relevance for the discussion.

Due to the relentless and accelerated speed of Artificial intelligence novelties, innovation management models will require a very robust effort of customization to be successfully adopted as a valuable tool to reshape and enhance innovative operational processes.

Indeed, the evidence obtained proved that a significant amount of effort is still required for the successful implementation of AI tools throughout the innovation pipeline, with the exception of: 1 ) the ideas creation and formulation early stages, 2) the preliminary composition of ideas and drafts. 3) the utilization of robust but generic applications such as calculations, text summaries, ideas trend detection, etc. Although the potential for future applications is huge, the investment required for the exploitation of AI capabilities is ambiguously high to estimate.

Artificial intelligence will become an indispensable element, in terms of competitive advantage, in order to drive innovation.

Although there are important differences of adoption and exploitation of AI depending on the industrial application, a common ground is settled for the ideas generation, evaluation, and problem domains. This means that AI has been applied mainly in the early stages of the whole end to end stereotypical close innovation pipeline.

Ultimately, the adoption of AI is being driven, as expected, by multiple factors, one of them being the necessity to maintain a competitive position within markets. As has been seen in many other technological transitions, there is an underlying uncertainty about the real economical potential of AI, this is one of the key reasons for companies to establish a management system that can facilitate its incorporation, evaluation and direction. Moreover, the wide landscape of uses cases and tools that are now under the umbrella of AI posses a huge challenge to countless firms and companies who may not know what is really going to become a competitive differentiation for them or even which path to take to enter the AI's race. Particularly in the case of small and medium companies, many of them are even struggling to catch up with digital adoption for their legacy computational systems, to them, the incorporation of AI seems a horizon that doesn't really promise to be aligned with their current business model or it is simple unfeasible to integrate it. As a result, the risk of creating a large technological gap between large and powerful corporations versus small and medium companies is major. This poses a thread to many employees as well, who may see how an AI agent may replace their jobs. Legislative implications are beyond the scope of this work, nevertheless, alignment with new regulations and laws will be extremely relevant for the current and future organizations that aim to manage AI. The implications of undermining the impact of legislation can be devastating for emerging and disruptive technologies such as this.

Finally, the models and methodologies proposed and developed fit their purpose of providing a fundamental baseline to address the intricate work of AI management and implementation. It proved to work as a minimal reference frame to figure out the steps required to leverage AI throughout an organizational process. It also allows to connect the most standard pre-existing process arrangements in companies to link them to new assisted AI tools, allowing a systematic transitions and a learning curve for innovations and managers.

## Future Research

AIIA's model functioning depiction and functioning as an integrated system may be able to provide better results in terms of flexibility and organizational implementation adoption, however, it may impact negatively its performance in terms of simplicity and facility to map a stereotypical waterfall innovation process. In regards to the algorithms described, further research and ad hoc applications can be implemented to come up with much more specific organizational use cases. Here is precisely where the value proposition methodology can be applied to derived further knowledge on the applications of words' embeddings and semantics. In terms of AIIA's applications, further research is required to review the state of the art technologies that are being published and proposed for financial and marketing forecasting. The same statement may apply to project management virtualization, where there are many basic applications being implemented, but none of them seem to be effectively impacting productivity and efficiency. In addition, deeper integration and a search for ethical elements must be incorporated into IM processes. According to the results shown, the regulatory and ethical aspects have a direct impact on organizations and AI implementations. Such an investigation may be the subject of a thorough analysis and discussion, as the legal framework of companies may vary significantly depending on size, culture, business line, and other factors.

Furthermore, further and future investigations are eminently required in order to evaluate and recollect the actual impact of AI within technological innovation, especially in terms of value recognition for product and service enhancements. Not to mention the limited if not null impact is shows for business value innovation.

As part of the contributions of this work, we used the definition of a product concept represented as a Gaussian distribution.

This means, the concept is defined by:

$$f(x;\mu,\sigma^2,) = \frac{1}{\sigma\sqrt{2\pi}} \exp^{-\frac{1}{2\sigma^2}(x-\mu)^2} \tag{20}$$

As a consequence, the definition of a product conformed by $n$ concepts is given by the multivariate Gaussian distribution:

$$f(x;\mu,\Sigma) = \frac{1}{(2\pi)^{\frac{n}{2}}|\Sigma|^{\frac{1}{2}}} \exp -\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu) \tag{21}$$

The universe of possibilities for the product given n concepts can be expressed as:

$$f(x;\mu,\Sigma) = \frac{1}{(2\pi)^{\frac{n}{2}}|\Sigma|^{\frac{1}{2}}} \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} ... \int_{-\infty}^{\infty} \exp -\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)dx_1dx_2...dx_n = 1 \tag{22}$$

It is expected to employ actual data to implement these equations in potential algorithms prototypes to complement the ideas generation and evaluation stages and evaluate the results. In addition, this equation raises the discussion of concept correlation. When developing products, it is clear that certain variables or features are not correlated. If we think of a simple gift box as a product, we can highlight three important features, for example, dimensions, color, and material.

We can easily notice that we can modify the dimensions of the box, but the color and material will remain untouched. Clearly showing that the three variables are not directly correlated. However, for product development and for future research use cases, we could state the correlation of all variables, based on the following assumptions:

A) Modifying a single variable or element within a system modifies the entire system.

B) A null correlation of variables may not indicate a lack of correlation but a dormant correlation.

C) Within a system we set $n$ variables where each and every one of them has a interaction with the rest... we will call this interaction chain of correlation.. in other words, there is no way to modify one variable without affecting the rest of them in one way or another.

We showed how some fundamental mathematical and computational tools such as the multivariate Gaussian distribution may be able to assist to find adjacent and juxtaposed sub-concepts, and we set the stage for future investigation to try to find ways to provide building blocks of ideas for the overall AIIA model.Also, we introduced the definition of 'concept normality', a normal concept is: a normally distributed idea conformed by a number of normally distributed ideas".

This means that a normally distributed idea shows a mean (the most commonly semantic or meaning that a given word evokes) and a variance (representing the dispersion of such idea). See here how the mean can reflect the description of the concept.

Ontologically, we could consider that there is only one concept that will contain all other concepts without exceptions: "Being". However, for basically any other concept we can find semantical proximity to find suitable applications in terms of concept descriptions. Now, a couple of assumptions to investigate are in order. The assumption is to say that every concept is identically distributed:

Hypothesis 1) Assuming an independent identically normal distribution (IIND) of all concepts, we can employ a central theory limit to conclude that any given concept is also normally distributed.

Hypothesis 2) The IIND of a Normal-Gaussian distribution is a suitable mathematical tool to create a pool of product concepts that favors product innovation.

Finally, more research is required in areas such as open innovation, which was excluded from the scope of this study. What is the actual impact of AI if we also consider an organization whose culture, processes, and practices also incorporate open innovation significantly? A mere speculative approach would be to consider that open innovation will simply be integrated as another input to ponder under a symbiotic AI-human innovation management environment.

## CONCLUSIONS

There is a generalized misconception about what artificial intelligence is. Although the definition is undoubtedly an open and ongoing debate, there seems to be a belief that artificial intelligence is a kind of pseudo-intelligent being or entity that can operate, adopt, and perform a wide range of intellectual activities exhibiting a rational behavior, almost as if it were a general artificial intelligence entity that materializes in certain products, services, use cases, but whose essence comes from an intellectual artificial machine that has replicated not only human cognitive patterns but a certain level of consciousness or awareness. The investigation helped to determine that great human effort, supervision, and support is still required to integrate AI into the IM processes. Also, even when AI is radically affecting specific steps of the innovation pipeline, at a managerial transversal level, it remains an important auxiliary tool, able to speed up processes, ease manual laborious tasks, but incapable to perform managerial skills to execute and implement innovation processes in the intricate complexity of real businesses and firms. We cannot forget that businessmen, entrepreneurs and many decision makers may not have the technical background to fully comprehend emergent technologies and they may not be getting inputs and training from the right people to make choices about their businesses or organizations.

Small, medium companies, entrepreneurs, and particularly innovation-creative designers, developers, and managers point out that -idea generation and evaluation- is a focal area where AI is already having a direct and high impact. Simultaneously, there is no evidence found that these ideas are actually impacting directly any relevant financial variable, this does not discard the potential profitability of AI, but it does reflect a lack of data to support correlation between AI implementation and financial impact. Furthermore, according to the feedback obtained during the validation of AIIA model, AI and especially generative AI is effectively helping to speed up the creation of certain types of products, such as logos, texts analysis summary, communication support assistants... but the implementation of this success cases usually comes with an important level of investment.

The massive concerns and inertia of AI seem to come from a different perspective. While AI is expected to become a financial game changer, innovation managers, entrepreneurs, and organizations seem to be urged to push this technology to develop the necessary skills to be part of the social, technological, and industrial adoption, even if there is not a clear alignment of the strategical companies' objectives with the incorporation of AI. To put it another way, there is a social inertia pushing to adopt a technology, but it is not clear whether such technology is actually generating tangible value. At this point, the discussion has to do with a different topic, social inertia, or technological trend as a driver of technology adoption. This means that regardless of whether AI is profitable or not, missing out on a pervasive technological trend is perceived as a treat and a weakness, and as a result, AI adoption value seems to be paying off in a rhetorical and performative way. For marketing purposes, this is a key point of discussion. In addition to the engineering and technical aspect of AI, the inclusion of technology is being driven as a marketing component. This aligns with an algorithm proposal for the AIIA model, the commercialization simulation. Let us dive into the impact of the results obtained directly on the model and the VP methodology.

According to the information received during the model's analysis and validation, the current most exploited capabilities of AI for the IM processes are ideas-generation and text analysis-composition.

The pace of AI has made it complex to evaluate and predict the way in which products are going to operate in real life, simply because new AI releases and features are being exposed on a daily basis, making it really hard to keep up with the state of the art.

Novelty does not necessarily mean value generation through successful adoption, countless users may select an older, or non state of the art technology to facilitate learning, usage, adoption, understanding and costs savings. There seems to be a bias in terms of technological comparison performance, where researchers are constantly looking for algorithms and solutions to outperform results, but where utilization adoption is often overlooked or even discarded. SMEs and no top leader organizations cannot always keep up the pace of state of the art, but they still play a huge role in society and economies. The concern of these organizations is around reliable technology adoption to keep businesses and value generation alive, regardless of what the state of the art is really.

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