

Extending Information and Communications Technologies' Impact on Knowledge Based Society through Artificial and Collective Intelligence

- Part 3 -



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Abstract

The paper is continuing our prior general analysis on the role of artificial intelligence (AI) and human intelligence (HI) in the context of Information and Communications Technologies (ICT) exponential development as driving factor of the Information society (IS) progress toward Knowledge Based Society (KBS).

Here some detailed aspects of the implementation and optimization of the emergent CI proliferation and use are approached, considering that the optimization of these processes at Earth scale has a huge importance and must aim the preservation and improvement of humankind life and evolution as main criteria.

The complex processes of the AI-HI and the ICT support are not independent, but they are working in a mutual dependence, which reveals and explain their exponential evolution and proliferation in IS/KBS, so the identification of the mentioned leveraging mechanisms are very difficult but, on the other hand, any progress in this direction is desired for optimizing and then efficiently using them in all activity fields at Earth scale.

The analysis shows that the efficiency of AI-HI applications is strongly depending on the human expertise/education and responsibility, when properly designing or using AI in CSOURS/CESENS and generally extracting information/knowledge from data all over the World, aiming the humankind stable progress in every activity field and ... beyond.

A special attention and analysis was given to improving the quality of human contribution for CI and generally to the optimization of the complicate processes where AI and HI are implied, from design to the implementation.

*This way, we have to face every day, from designing to implementing or using AI/ICT, the fundamental question **whose wisdom to trust?** (WWTT?), recalling the prominence of HI and human wisdom (HW), because definitely behind any AI/ICT product/service is HI and HW!*

As a conclusion, we consider that (WWTT?) is not necessary a question to be answered, but an alarm signal to prevent the consequences of not carefully choosing our decisions or analysing our options for designing and implementing AI-HI projects, but generally any project in the ICT/IS/KBS fast changing and complex context.

We consider that WWTT? could be really understood and perhaps properly followed, as an alarm signal inside and outside AI-HI, for a sustainable development of ICT/IS/KBS and humankind life on Earth.

Keywords: artificial intelligence, human intelligence, Big Data, crowd wisdom, collective intelligence, crowdsourcing, machine learning, knowledge engineering, natural language processing, opinion mining, information society, knowledge based society.

JEL Classification: L63; L86; M15; O31; O33

1. How Information and Communications Technologies support the intelligence

Intelligence is the ability to adapt to change - Stephen Hawking

We live in a complex and fast changing reality, but a first step to understanding it is to observe that our World is more and more divided in two: the physical world and the information world.

The more correct perception is that along with the physical world, we have to witness how the information becomes not only an increasing new parallel/associated world, but the main value.

Here we have to point that it is not the virtual reality (VR), nor even the augmented reality (AR) that we are talking about, although information is an elementary notion which is difficult to define and measure, but it is practically associated with every physical entity (as AR is also starting to express) and ... more!

In fact, the Information and Communications Technologies (ICT), as the main driving factor of the Information Society (IS) toward Knowledge Based Society (KBS), have progressively built this new World, giving to information a concrete meaning by continuously influencing all human activity domains and even Earth ecosystem.

This way we can better understand the essential link *Stephen Hawking* made between the reality problems and intelligence, suggesting that it is the main ability we have to develop for humankind survival and progress on Earth.

The intelligence role analysis is also our prominent goal, not only in this paper, but in other similar approaches we have made too [3][22][18].

Speaking about intelligence, we have to show that not only human intelligence (HI) should be considered, but all kind of natural or artefactual ways to optimize the change, facing all challenges of the implied complex processes, at Earth scale.

Making the link with ICT above mentioned context, including advances like Cloud, Big Data, Internet of Things (IoT) and artificial intelligence (AI), we have to observe that AI is perhaps the most dynamic and important element we should analyse, considering its huge benefic implications, but also challenges[13][14][16][19][21][25][26].

Another reference point for further analysing intelligence issues is to recall Albert Einstein's quotation, "***The true sign of intelligence is not knowledge but imagination***", which is an argument for the opinion that HI is still superior to AI by the unlimited capacity of imagination and in fact shows the way both cooperate, generally as collective intelligence (CI), to humankind progress with ICT general support – as we have already suggested [3].

In order to sustain these opinions, some actual examples and trends could also express the ICT support, but, for such complex processes, a systemic approach is necessary and has to begin with identifying the main areas of development and challenges of the ICT/AI/HI context.

Continuing our prior general analyses [3], here we approach some detailed aspects of the implementation and optimization of the emergent CI proliferation and use.

We consider that the optimization of these processes at Earth scale has a huge importance and must aim the preservation and improvement of humankind life and evolution as main criteria, which is also very well expressed in [1]:

“Human-Centered Collective Intelligence (HCCI) is an emergent research area that seeks to bring together major research areas like machine learning, statistical modelling, information retrieval, market research and software engineering to address challenges pertaining to deriving intelligent insights and solutions through the collaboration of several intelligent sensors, devices and data sources... Some of the key quality concerns of interest in CI scenarios span the gamut of security and privacy, scalability, performance, fault-tolerance and reliability... I dive into the design of optimal architectures that allow humans and intelligent systems to work collectively to solve complex problems”

Without limiting our approach to the above concept and content, it is clear that the general purpose of CI must be to **“allow humans and intelligent systems to work collectively to solve complex problems”**.

A first amendment to the above content is to recall the importance of *crowd wisdom* (CW) in crowdsensing (CSENS), especially in crowdsourcing (CSOURS) and generally in CI[6][22].

This means that we want to emphasize, for the dramatic evolutions of ICT/AI, the role of imagination for innovation and the efficiency that HI could bring in the CI processes, based on life experience and expertise.

For the systemic approach, here it is essential to recall the prominent leveraging and linking role the general context of ICT/IS/KBS support has in CI progress. This way CI could be characterized by some features, as expressed in [5]:

*“The growth of human collective intelligence follows the improvement of media
Media, Cultural Evolution and Knowledge...*

Displayed around each people, community, thing, place, work of the mind...

Interaction through holograms in VR or AR, by Google glasses or tablet...

*Embedded powerful tools for selection, exploration, analysis, synthesis, semantic
distances measurement...”*

Of course, beyond these systemic connections and interfaces, a huge diversity of networks, equipments and software/applications represent the concrete support of implementing CI, including the AI-HI symbiosis.

It is important to observe the complex processes where the AI-HI and the ICT support are not independent, but they are working in a mutual dependence, which reveals and explain their exponential evolution and proliferation in IS/KBS.

This is why the identification of the mentioned leveraging mechanisms are very difficult but, on the other hand, any progress in this direction is desired for optimizing and then efficiently using them in all activity fields at Earth scale.

Although it could appear not the most important level, we consider that the efficiency of AI-HI applications is strongly depending on **the human expertise/education and responsibility**, when **properly designing or using AI in CSOURS/CSENS and generally extracting information/knowledge from data all over the World, aiming the humankind stable progress in every activity field and ... beyond.**

This opinion is also confirmed by the way collective memory, personal responsibility and knowledge management are presented in [1]:

“Personal responsibility of collective memory

- *Actions in the digital medium: subscribe, buy, comment, record, broadcast, hyperlink, tag, approve/like, participate to a group, communicate etc.*
- *Every digital action sculpts the collective memory.*
- *We are all potentially readers, spectators, authors, critiques, editors, publishers, curators, librarian and co-responsible of the collective memory.*
- *Knowledge society citizenship: help/orient others.*

Personal Knowledge Management

1. *Attention management:*

Define interests, priorities, areas of expertise (acquired and aimed);

Stay focused, avoid distraction, keep in mind the big picture;

2. *Connection to valuable sources–Information streams from people and institutions*

3. *Gathering and aggregation of data streams*

4. *Filtering – Manual and automatic (according to 1)*

5. *Categorization – Tagging, folksonomies, classifications, ontologies”*

Confronted with such a large context, it is important to “keep in mind the big picture” and try **to best match all the components with the responsibility of living in IS and building KBS, knowledge by knowledge!**

Among the components, we have already pointed that the main mechanisms of developing CI have a systemic role, so it is useful to observe how the ICT support could be better used, i.e. how to combine technological innovations with new ideas from CW in new productive actions and expression forms, as is suggested by[12]:

“We are witnessing an unprecedented convergence of advances in processing power, interconnectivity, cheap data storage, high fidelity rendering, physics simulations, and natural language technologies. The combination of these technological innovations lays the foundation for new mediums of communication, allowing us to tell stories in ways never before possible. Each new communication medium changes both what stories can be told, and how stories can be told.”

Consequently, **AI and HI could bring together new stories/actions in new productive ways, including new business models, products and services, by refining knowledge every day and ... every way.**

A more concrete imagine of these mechanisms is naturally offered by the most dynamic field of applications of ICT support, the economy, where AI-HI are cooperating for speeding the progress, as it is given by the next example[24]:

“Knowledge engineering is key for enhancing organizational capabilities to gain a competitive edge and adapt and respond to an unpredictable market environment. Such knowledge can be generated from collected data which is often considered complex. Organizations are collecting vast amounts of data to transform them into real-time information in order to attain successful decision-making support systems. It is more than likely that such processes can be challenging; yet such knowledge must be extracted from thoughtfully designed and implemented data warehousing, and mined to obtain the required information... Firms are collecting vast amounts of data daily and developing advanced data warehouse systems to secure the data. Their intention is transforming it into vital information, or knowledge, for developing decision support systems”

Here we consider that the mention of *Knowledge engineering* is a relevant confirmation of the crucial importance of AI-HI for the approach of IS toward KBS, as we have already presented[26][22], but still needing to be timely analysed with all associated implications as ICT support is exponentially increasing.

It is also worth to observe that the role of refining knowledge, essential in KBS, is so important because it exploit data *“transforming it into vital information, or knowledge, for developing decision support systems”*, exceeding economy and having benefic influence for all activity fields, for humankind evolution and beyond ... for Earth ecosystem.

In addition, the prominence of data mining and the mandatory *“thoughtfully designed and implemented”* applications reveal the essential role of human contribution in such complex processes.

This way we could conclude that **a special attention and analysis must be given to improving the quality of human contribution for CI and generally to the optimization of the complicate processes where AI and HI are implied, from design to the implementation.**

2. Recalling a perpetual dilemma of science: whose wisdom to trust?

The optimization of ICT development, where it is obvious that AI and HI are prominent and interdependent factors, is a complex and very difficult multicriteria problem, as we have already presented [18][9].

Even if we could restrict ICT development to the applications where AI and HI are the main ingredients, which anyway are fast extending, a realistic short analysis should focus on the most relevant criteria of the optimization and then link them with HI or AI as it is the case.

Among the most important criteria for generally optimizing ICT for IS/KBS and especially the AI-HI symbiosis, by our opinion, include the sustainable development of ICT/IS/KBS, having as concrete components the green ITC (climate changes, carbon footprint reduction, Earth resources saving etc), humankind survival and healthy progress in Earth ecosystem.

In order to best promote these aims, both AI and HI must perform best in part but especially in their interdependent development, as it could be further analysed by some examples, where the best solution is to get maximal reach of the weighted above criteria, using or creating the highest technology.

In the same time, we have to observe that each case needs an appropriate combination of weighting the prominent criteria, which in fact could be another very difficult problem, especially in complex cases where evaluating or measuring all criteria is nearly impossible, but usually could be approximated.

As section 1 was mainly focused on ICT/AI support, here the human contribution in the AI/HI symbiosis will be pointed considering, in a first approximation, that HI could be generally associated with “wisdom”, although for humans the wisdom is more than HI, but when comparing with computers, AI tends to reach HI and perhaps in the future this will be closing to wisdom.

More than these, we consider that, in order to provide a sustainable development, in the conditions of emergent penetration of AI/ICT in vital areas like self driving cars or planes, but not forgetting critical infrastructures like energy, IoT or health systems, **the trust in “that intelligence” is the key factor.**

With simpler words, we will face every day, from designing to implementing or using AI/ICT, the fundamental question **whose wisdom to trust?**

This way we came **back to the prominence of HI and human wisdom (HW), because definitely behind any AI/ICT product/service is HI and HW, from designing to implementing or using it!** So the *Albert Einstein’s* quotation (*The true sign of intelligence is not knowledge but imagination*) is again relevant.

The new and complicate situation is that the efficiency of human capacity to build and properly use AI/ICT systems/services is more and more leveraged by ... AI, so the pressure on properly designing them is naturally increasing.

Still, the human intrinsic capacity remains essential for HI potential and this is why it is the first criterion for selecting people involved in CI projects, i.e. this is here the first meaning of **whose wisdom to trust?(WWTT?)**, but this is not the only case.

As a matter of fact, **WWTT? is not a new issue, nor an exclusive scientific one, but generally is a decision matter people have to take every time in a diversity of problems, depending on individual philosophy, as one could naturally ask: why worry for everything?**

We believe that the answer will be always depending on the education/expertise level of individuals and on this basis the philosophy could be considered then.

The truth is that we take a decision even when we say that is not the case to take a decision or seriously think to something, but this option will surely have its consequences.

This way we have just came back to the point, as there are many situations to answer WWTT?, as for choosing experts, ideas, models, algorithms or technological solutions!

As a conclusion, we consider that (WWTT?) is not necessary a question to be answered, but an alarm signal to prevent the consequences of not carefully choosing our decisions or analysing our options for designing and implementing AI-HI projects, but generally any project in the ICT/IS/KBS fast changing and complex context.

We have to notice then that it is possible that sometimes a better contribution to come not from the person who has the highest ranking, but usually this is not the case, proving just the importance of CI, where relevant contributions could come from many places.

In fact, as we already have pointed by “**interdependent development**”, HI/HW and AI are in a vicious circle of mutual influence, but the real dilemma is not which is the first, because we have showed that human is prominent.

We have recalled “science dilemma” considering just the need to carefully/precisely select/optimize human contributions (HI/HW), but not neglecting to also select AI contributions, using as much as possible scientific/technical means (without excluding HI for AI selection), especially in the actual ICT context/support, where AI, Cloud, Big Data or IoT could help to find in each case the best solution.

Coming back to the actual importance of CI and CSOURS, a relevant example of AI role in evaluating CSOURS by machine learning is given by [11]:

“We present the design of CLOWDER, which uses machine learning to continually refine models of worker performance and task difficulty. Using these models, CLOWDER uses decision-theoretic optimization to

- 1) choose between alternative workflows,*
- 2) optimize parameters for a workflow,*
- 3) create personalized interfaces for individual workers, and*
- 4) dynamically control the workflow”.*

The advantage of optimizing the CSOURS workflows by machine learning (AI) is obvious, but the real case applications could be very complex and complicated, not only by the number of “*alternative workflows or parameters*”, but by the necessary metrics to evaluate them in the diversity of matters/jobs associated with the workflows.

We have just arrived to one of the most difficult actual problems of implementing the most advanced ICT: the lack of appropriate performant models.

Here the models would express the metrics to evaluate the workflows and generally the contributions, either from HI or AI on spot, i.e. to answer anytime the essential question: **whose wisdom to trust?**

As there is such a huge need of mathematical models for the very complex areas or systems, the heuristic approach is more and more extending for some classes of applications, so it fits very well with CI.

A good example for such areas is the user experience measuring[22] and this is also expressed in[4]:

*“The digital age is characterised increasingly by the collective. The information generated by tapping into the minds of many is driving decisions in both the public and private sector; research is becoming social. On the back of this, **a new science has emerged – known as opinion mining** – which uses the latest advances in artificial intelligence (AI) to mine public opinion for sentiment. This structured data is known as opinion data. By analysing online public opinion, governments and global organisations can now access a set of insights that can shape strategy and better measure the public’s experience of their policies, service and brands.”*

We consider that this area has a special importance by its potential to be expended in other fields of IS/KBS, as “governments and global organisations” could be influenced to use refined knowledge for a sustainable development, including ICT pace and trends, benefic for humankind and Earth ecosystem, as we have mentioned in section 1.

This possibility is also confirmed by other sources, as is expressed in the next example [8]:

<< *The crowd, as a group of people, think, make decisions, learn and act. Imagine obtain and store all these reactions, information and beliefs in one place, this is crowdsourcing. “Crowdsourcing is the process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers.” is the crowdsourcing definition. Well, let’s now consider to take the opportunity to data mine crowdsourcing results and import it, in a serial way, with matching techniques into this “consciousness”. Our AI system will learn by a several big amount of data, which means we will have a lot of different instances of each object and a different connection to each other. By using this, the power of crowd, we maybe be in place to say that this consciousness will use a catholic “think” way to act and react to different circumstances and it will start to have an objective consciousness, an its own consciousness. In this way, the AI system that will be created would be used in common problem solving issues that would compare standard knowledge with crowd’s opinion - thoughts.* >>

Again it is pointed the importance of refined knowledge and how this could leverage the sustainable progress, but more than this, it is suggested the model of evaluating the progress by “*compare standard knowledge with crowd’s opinion - thoughts*”.

Speaking of models we can come back to the above mentioned “meaning of **whose wisdom to trust?**”, as it is possible to choose between different complex sets of data using *machine learning (ML)* with the appropriate models or algorithms, as it is largely presented in [17]:

“*Today, machine learning (ML) has impacted an enormous number of industries; including retail, healthcare, robotics, mobile app development and travel. Usually, people interchange the terms Artificial Intelligence and Machine Learning. However, they are different. Artificial Intelligence is the concept of making machines capable to performing tasks without human intervention, such as building smart machines; while Machine learning (ML) is a subset of AI based on the idea of making computer algorithms that automatically upgrade themselves by discovering patterns in existing data without being explicitly programmed. The whole processing of ML tools depends on data. The more data an algorithm obtains, the more accurate it will become and thus, the more effective the end results will be*”

In addition to these general ML features, some prominent areas and ways of implementing the AI/ML resources and models, for improving life and generally the progress of IS/KBS, are also given:

“At present, ML-based NLP (Natural Language Processing) is still in its infancy. Right now, there’s no such algorithm available that could understand that various words have a different meaning in different situations and act successfully. However, it is expected that such algorithms will come into existence in the future...”

In 2014, Skype launched an application called Skype Translator which translates speech from one language to another in real-time. Since then, it has undergone various updates. If it continues to evolve in the same way, we will soon be able to enjoy high-quality international communication – eradicating language barriers...

Machine learning is also becoming a buzzword in the healthcare industry. It is used for different purposes, like drug discovery and robotic surgery.

Recently, Google created a machine learning algorithm that helps detect cancerous tumors on mammograms, while Stanford is using the technology to identify skin cancer...

*Machine learning tools, along with **Big data analytics** is used by the mobile app developers and marketers to understand how the users interact with a mobile app and group the data under different categories for predicting next step to be taken for engaging users and increasing the conversion rate.”*

For sure all these areas are very important for human life, but health diagnosis is vital, while predictive analysis has the potential to be used beyond user experience domain, in the complex context of ICT implications in all activity fields or other critical areas like climate changes forecasts [15].

The relevant challenges of AI in the medical domain, centered on (WWTT?), have been recently presented in [2]:

<<The health care industry may seem the ideal place to deploy artificial intelligence systems. Each medical test, doctor’s visit, and procedure is documented, and patient records are increasingly stored in electronic formats. AI systems could digest that data and draw conclusions about how to provide better and more cost-effective care...

So what’s the holdup? It’s not technical, says Shinjini Kundu, a medical researcher and physician at the University of Pittsburgh School of Medicine. “The barrier is the trust aspect,” she says. “You may have a technology that works, but how do you get humans to use it and rely on it?”

Most medical AI systems operate as “black boxes” that take in data and spit out answers. Doctors are understandably wary about basing treatments on reasoning they don’t understand, so researchers are trying a variety of techniques to create systems that show their work>>

We consider that in this case we meet perhaps **one of the most relevant confirmation and support for our paper aim, as here we can see not only the importance of thrusting the new AI-HI projects, but more than this, the benefits toward performance obtained if we responsibly and creatively link AI with human expertise and imagination, i.e. just what the doctors strive to do.**

After these examples, the above mentioned difficulty of implementing the most advanced ICT, as AI-HI projects, we mainly have identified as (WWTT?), has become clearer, although we have observed just the iceberg tip.

Perhaps a more comprehensive picture of CI implementation challenges as (WWTT?) is that presented and detailed analysed in [7] for organizations incumbents:

“Control One key concern, common to all forms of collective intelligence, is a loss of control, which can manifest itself in a variety of ways. One is, simply, unwanted and undesirable outcomes — the collective makes a decision that could harm the company, revealing either a flaw in managers’ thinking or the improper application of collective intelligence. Another is unpredictability — a decision might not necessarily be bad per se, but the organization is caught unprepared to deal with it. A third is unassigned liability — who is responsible for a poor decision made collectively? Moreover, companies need to be aware of the potential for snowball effects. Through self-organization, an opinion might gain nonlinear momentum through self-amplification. This can lead to public relations nightmares if the collective involves participants external to the organization. Consequently, one of the biggest issues with respect to control is whether to include outsiders in the process.”

In the same paper, our above concern about the implications of subjects/jobs/applications diversity when answering (WWTT?) is also confirmed with concrete arguments:

“As mentioned earlier, decision making that makes use of a collective requires a company to strike the right balance between diversity and expertise. Certain problems lend themselves to a diversity-based approach more than others, but no amount of diversity will help if the participants are completely ignorant of the issues. Another factor to consider is the actual composition of diversity: In the same way that sampling biases exist in polls, the diversity of a large population can also be skewed, leading to distorted decisions. Thus, organizations need to decide which people to involve based on the ability of those individuals to understand the problem at hand and collectively make positive contributions to solving it.”

An interesting presentation of the same challenges, this time pointing the AI benefits and associated responsibility (including Dependency Dilemma), we also identified in the area of projects design and generally in the HI side, is shortly expressed in[10]:

<< For me, the greatest advantage of dependence on AI accrues to the engineers, scientists, venture capitalists, start-ups, and mega-corporations creating dependence on AI. For sure there are, and continue to be, benefits on the user side of the equation as embedded technical intelligence enables the doing of things, the creating of things, the grasping of things, [which was] never possible before. Those benefits are the result of our using technology to free up effort for more fruitful application, not from looking to technology to do the work for us.

These benefits stem from what John Markoff, in his latest book, Machines of Loving Grace, calls IA: “intelligent augmentation” as distinguished from AI. The term, AI, Markoff writes, coined in 1964 by math and computer scientist, John McCarthy, was designed to “mimic” or replace human capabilities. “Today,” according to Markoff, “the engineers who are designing the artificial intelligence-based programs and robots will have tremendous influence over how we will use them. As computer systems are woven more deeply into the fabric of everyday life, the tension between augmentation and artificial intelligence has become increasingly salient.” He adds that there is also a paradox: “[The] same technologies that extend the intellectual powers of humans can displace them as well.” >>

This concluding and severe remarks are also relevant for our repeated concerns [9][15][18] about the necessity to analyse all the consequences of AI/ICT fast pace of development, but if these are not sufficient, the author finally also launched an alarm signal which is multiplied by quoting other authors:

<<In a reflective step back from his 1980s profile of MIT's Media Lab, Whole Earth Catalog founder, Stewart Brand, mused that "New technologies create new freedoms and new dependencies. The freedoms are more evident at first. The dependencies may never become evident, which makes them all the worse, because it takes a crisis to discover them". That observation was made more than a quarter century ago – and it seems that little to nothing has changed. Echoing Brand's observation, Vardi tells Cherry that "We run away with technology and deal with the consequences later". >>

Finally we consider that WWTT? could be really understood and perhaps properly followed, as an alarm signal inside and outside AI-HI, for a sustainable development of ICT/IS/KBS and humankind life on Earth.

3. Conclusions

Continuing our prior general analyses, here we have approached some detailed aspects of the implementation and optimization of the emergent CI proliferation and use. We consider that the optimization of these processes at Earth scale has a huge importance and must aim the preservation and improvement of humankind life and evolution as main criteria.

The complex processes of the AI-HI and the ICT support are not independent, but they are working in a mutual dependence, which reveals and explain their exponential evolution and proliferation in IS/KBS. This is why the identification of the mentioned leveraging mechanisms are very difficult but, on the other hand, any progress in this direction is desired for optimizing and then efficiently using them in all activity fields at Earth scale.

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A special attention and analysis must be given to improving the quality of human contribution for CI and generally to the optimization of the complicate processes where AI and HI are implied, from design to the implementation.

We have to face every day, from designing to implementing or using AI/ICT, the fundamental question **whose wisdom to trust? (WWTT?)**, recalling **the prominence of HI and human wisdom (HW)**, because definitely behind any AI/ICT product/service is **HI and HW!**

As a conclusion, we consider that (WWTT?) is not necessary a question to be answered, but an alarm signal to prevent the consequences of not carefully choosing our decisions or analysing our options for designing and implementing AI-HI projects, but generally any project in the ICT/IS/KBS fast changing and complex context.

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