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Digitization and Transformation

Digital & Virtual

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Abstract

The terms or methods Business Automation - AN, Business Automation - AN, Digital Automation - AD, Digital Transformation - TD, Digital Business Transformation TDN, Virtualization, are used in several theses in different areas, such as management, IT, Telecommunications, Industrial , Services.

With the advent of Artificial Intelligence, these terms and their definitions must be revisited, because as we see, there is a confusion or diversification of the barriers defined for digitalization and transformation, mainly using the term digital.

In the meantime, we determine the problem regarding the Digitization and Transformation methods, thus proposing to delimit the barriers of use in comparison with application in the real and virtual world.

Using the PRISMA methodology to systematically obtain materials and through a literary review of scientific publications focusing on definitions, characteristics and requirements in a restricted manner of the question elaborated, which provided few papers in which we realized the paramount importance of visiting this theme.

The objective of this work is to define how to characterize the terms Digitalization and Transformation, as well as the application of digital and virtual to them.

Finally, the results, discussions, proposals and conclusions obtained will be based on developing and/or proposing future work on a mathematical evaluation model and/or framework to have a model that can determine, classify the method in any company that you want to implement with your derivations.

Keywords: Automation, Transformation, Digital, Virtual, Real.

1. Introduction

In order to improve reading and speed it up, in each chapter we will initially describe its composition in a way that can speed up and improve the reading of this work.

The composition of this work has introduction, methodology, results and discussion chapters.

In this chapter we have: Introduction and Contextualization to list some fundamental concepts in chronological order to construct an analysis of this work.

Identify problems related to understandings about transformation and digitalization, physical and digital environment, virtual or real reality and seek to concretely identify the main difficulties in these relationships.

We will then describe the methodology used in the proposed research and the conceptual identification of the methodology and technologies used in it, the motivation that led to the choice of the topic and, finally, the structure of the work as a whole.

After seeking to respond to the updated concepts for these relationships according to the methodology, we will try to create a conceptual framework so that this work can be input for further development in this author's Digital & Visual transformation doctoral thesis.

1.1 Contextualization

Talking about the Digitalization and Transformation methods and their applications in the Real and Virtual world, we believe that we should list at least what we understand as the beginning of these terms in the modern age, that is, the four phases of the Industrial Revolution:

First: Mechanization¹ [1]

Second: Evolution² [2]

Third: Computerization³ [3];

Fourth: Automation⁴ [4];

Thus we realize that the term Transformation has been constructed since the first revolution, still in real mode, with digitalization being added to both after the fourth revolution.

Therefore, this work will aim to delimit these two terms (Digitalization and Transformation) in the same way as their possibilities in the Real and Virtual world, as automation we understand is a possible variation between these two worlds.

¹ Transformation: Regarding work, it is clear that what occurred was the transformation from manual to mechanical.

² Evolution: Improvements and new technologies.

³ Computerization: Beginning of Digital, implementation of computers in business.

⁴ Automation: Regarding automated business processes, carried out/controlled by machines.

2 Problem

If we consider the terms automation and transformation, we can observe that they are not new, as the Transformation method predates the automation method.

With the digital revolution we began to exhaustively adopt the terms digitalization instead of automation and in recent decades digital transformation, as well as, currently virtual and virtualization.

When we search using only “transformation” OR “digitization” as a criterion in the IEEE Explore database [5] we have more than 160,413 thousand works that use the terms digitization and Transformation, considering the entire available data range.

But, when we try to analyze the terms Transformation and Digitization with the exclusion criteria “Requirements” and “Definitions” with a current date range (2018 - 2024) we only obtain three documents, as can be seen in detail in 3.1.1 - Initial criteria applied to the research.

We can see that we have two realities: Real and Virtual and it is also easy to understand that we have the means: Physical and Digital.

This way we can understand that digitalization and transformation are distinct items.

The use of the term digital is widely used in transformation, confusing medium with reality, and thus we can understand a lack of clear definition of these terms and their correct use with the advent of virtual reality and/or AI⁵.

2.1 Objective

As identified, this work seeks to answer what is Digitalization and Transformation? As well as the means they use.

As a final objective of this work, to respond to or provoke the understanding of the relationships generated by the framework in the following figure:

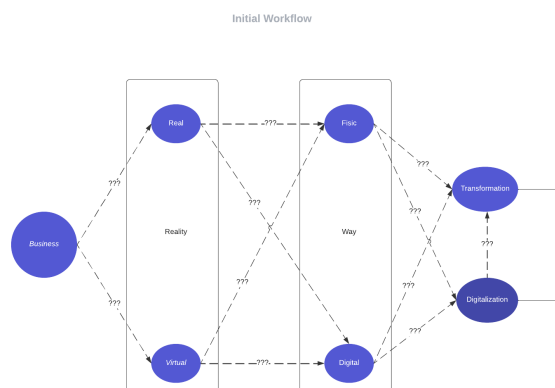


Figure 1 - Initial Workflow

⁵ AI - Artificial Intelligence

3.0 Methodology and Database

This review of reports was prepared adopting the Preferred Reporting Items for Systematic and Meta - Analysis - PRISMA methodology [6].

This chapter is thus divided: Criteria Applied for Research and Report Study by Selection.

Therefore, we began by defining what would be the object of this review in order to develop the research criteria to be carried out in a restricted manner.

Using the IEEE Xplorer Digital library database as the main source, applying the determined filters and criteria, which will be demonstrated during item **3.1 - Criteria Applied to Research**.

3.1 Criteria applied for Research

Considering the PRISMA 2022 methodology, which is a guiding workflow, being flexible to define the research method while maintaining a recognized scientific process.

3.1.1 Initial criteria applied for Research

In this way, we composed the modeling of the IEEE Xplorer Digital library, considering the results after applying the following filters:

Keyword	Constrain
Digitalization	AND
Transformation	AND

Table 1 - Selection Filters

Following the methodology and formatting to search for the object of this work, we adopted the following report exclusion methods:

Keyword	Constrain
Requirements	AND
Definitions	AND

Table 2 - Exclusion Filters

The result obtained were three papers that were presented at conferences, namely:

- Toward a Game-like Experience: Design of a Modern User Interface of a Simulation Game for Teaching Business Process Digitalization. [7]
- Industry 4.0-compliant Digitalization of a Re-configurable and Flexible Laser Cutter Module within a Digital Factory. [8]
- Recommendation of Best Practices for Industrial Agent Systems based on the IEEE 2660.1 Standard. [9]

As in these papers we applied the exclusion criterion (Magazines), which can be observed more rigorously in table 6 of item 3.1.2 - *Adjusted Criteria applied for research*, thus being disregarded for study.

In order to improve the materials available in the same database, we revised the selection criteria, as follows.

3.1.2 *Adjusted Criteria applied for Research*

Using the same IEEE Xplorer Digital library, considering the results after applying the following filters:

Keyword	Constrain
Digitalization	OR
Transformation	OR

Table 3 - Adjustment Selection Filters

Adopting time as a criterion, we restricted the period to:

Begin	Finish
2018	2024

Table 4 - Range Date

Likewise, according to the methodology adopted, we adopted the following exclusion criteria in the adjusted selection:

Keyword	Constrain
Requirements	AND
Definitions	AND

Table 5 - Exclusion Filter

Following the methodology and formatting to search for the object of this work, we adopted the following report exclusion methods:

Edition	Quantity
Conference	98
Magazines	4

Table 6 - Exclusion Fiter Reports

In order to adjust the methodology to obtain the areas that may be material to respond to the object of this work, we will divide it into the following areas of study:

AREA	FILTERS
Real	ANALISYS
Digital	ANALISYS
Virtual	ANALISYS

Table 7- Area by Study

Thus, we obtained the following studies by area to be eligible for primary literary review:

AREA	PAPERS
General	10
Real	12
Digital	9
Virtual	4

Table 8- numbers by area

Therefore, finalizing this composition of criteria and definitions so that we have reports by area of study in order to validate the issue that is the subject of this work.

In this way, we can demonstrate the complete flowchart of the literature that will be reviewed in figure 1:



Figure 2- Full flowchart Criteria & Analysis

3.2 Report Study by Selection

As detailed in section **3.0 Methodology and Criteria**, the methodology applied and adapted as a selection, exclusion and filtering method generated thirty five articles that we will separate by study area related to the objectives proposed for this work, twelve of which do not apply to the context of this work, and one book with only permission to abstract content⁶.

4.0 Results

As detailed in the previous sessions, the methodology applied, with method, selection and exclusion criteria above we collected thirty one articles valid for the main source.

Our review considers it an analysis restricted to the selected papers, being focus into the following themes:

- General;
- Real;
- Digital;
- Virtual;

4.1 General

In the item proposed after segmentation and the process already explained, the item “General” generated ten records in English obtained from the IEEE Xplore digital library, four of which do not apply to the context of this work.

The volume created by Big Data and the need to classify it, quantify it, providing adequate security both in terms of use and this information, make it the main input for digital and/or virtual transformation [10].

Through computerization and thus the digitalization of information, which can be multiple sources, they currently generate a large volume of data - Big Data, which becomes an essential factor in achieving or measuring transformation [10], [22].

In this composition we will have to increase memory and processing capacity given the volume of data that the transformation requires [11].

The structural basis to support digitalization and/or transformation requires the constant development of transport networks, backbone, access and security mechanisms to sustain the business [11].

The definitions and requirements are of fundamental importance in the composition of any transformation or digitalization model, thus allowing the development of framework and/or algorithms that can provide with certain assertiveness the stage, maturity of the transformation or digitalization [12], [13], [22].

⁶ Reference [28] - Digital Transformation Using Industry 4.0 and Artificial Intelligence

When we are working with requirements and definitions, their parameterization must be observed with criteria of weights and counterweights, as the determination of the weight of each point depends on the interpretation of the stakeholder.[14].

Through a structured system, a control mechanism can be adopted to classify the degree of assertiveness of the desired output, that is, the need to have definitions, clear requirements, are of paramount importance to determine any model that determines stage, maturity of a transformation or digitalization [15].

In contrast, digitalization in its current form also carries a high volume of data, but it can be in isolated sectors, thus being a factor to be studied to establish the divergence between the transformation [25].

One of the major technologies that can be use to a digitalization or transformation is M2M⁷, IoT technology being one of the great actors of change. However, the safety factor becomes paramount in the use of this technology [15], [17], [24].

The parameterization of possibilities and their analysis provide a matrix of countless inputs with defined requirements and with this we will have the possibility of structuring it [16], [22].

4.1.1 Framework about Information

As a proposal for the analysis of general items, we propose the following holistic framework model from the perspective of information.

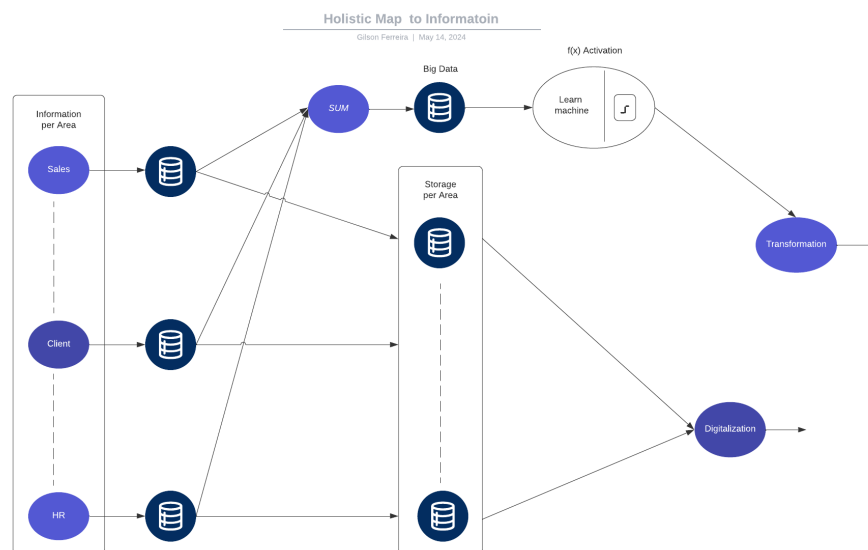


Figure 3 - Analysis by Information workflow

The first output for this analysis, we can consider that from the perspective of information, which can come from countless sources when consolidated and treated, and by applying Learning Machine or intelligence analysis we can understand that we have a transformation.

⁷ M2M - Machine to Machine

The second output for this analysis, we can consider that from the perspective of information, its when we collect data and they are not used together or combined, this approach, we can understand that we have digitalization.

4.1 Real

In the item proposed after segmentation and the process already explained, the item “Real” generated twelve papers in English obtained from the IEEE Xplore digital library, four of which do not apply to the context of this work..

In traditional transformation models it is based on the automation of activities in order to act as a process sequenced in time, not observing the variations of data over time [17], [21].

When we use real structures with digitization we can incur errors of variations, noises, which can be parameterized, but in the transformation the structure must be able to adjust to the new model almost autonomously [18], [19], [22].

The transformation of a real system should take into account the need to determine not only the requirements with determinable correlation, but should consider a framework with the indeterminable variation of its information correlation [19].

The real structure when digitized becomes an automated model of the previous process, but when we want this same structure to have a transformation this must be done so that it can change its configuration with a certain autonomy without the need for structural reforms [20], [31].

When we analyze the structures that promote the digitization of data, we perceive the limitation of the evolution of physical capacity, so for transformation we must look for models, frameworks that enable this growth or reduction in a more dynamic way [21], [23], [31].

Transformation models in real environments, such as industries, can be easier to understand, because it goes from automation with the digitization of activities and through the volume of data, these can be worked with study so that you can carry out the transformation with AI [22].

The security requirement is one of the most complex when we use it in the process of digitization and also transformation, especially in the use of IoT technology [23], [25].

4.2 Digital

In the item proposed after segmentation and the process already explained, the item “Digital” generated nine papers in English obtained from the IEEE Xplore digital library, two of which do not apply to the context of this work.

The most used current model is the digital medium, in which we have in the digitization the composition of the data with the possibility of analyzing them with the rules and probabilistic models for the analysis of errors and deviations, being the transformation, when we apply AI to automate these adjustments [18].

With digitization, the complexity of ensuring data integrity refers to the need to obtain levels of security for each use scenario [25], [31].

With the evolution of technologies, the digitization in which you use the digital medium has been assuming or confusing it with the virtual world [26].

The digital medium becomes extremely dangerous every day, because with digitization we can contain the information and thus apply security mechanisms, but when we enter the transformation, especially in the virtual environment factor and security processes must be constantly reviewed and the nerve center of the feasibility of integrity and security[27].

The evolution of AI has been modeling the concept of digitization, turning it into a digital transformation, which will probably evolve into the most complete model of transformation, from real to virtual [28]⁸.

The process to consider a consolidated transformation involves the need to increasingly apply AI, in which it makes the virtual transformation robust allowing the virtualization of various means [22].

The processes to determine the requirements and definitions of digital structures must be well elaborated and pursued to clearly have the composition of the structure and its form of evolution and security. [29].

4.2.1 Framework to Security

As a proposal for the analysis of digital items, we propose the following holistic framework model from the security perspective:

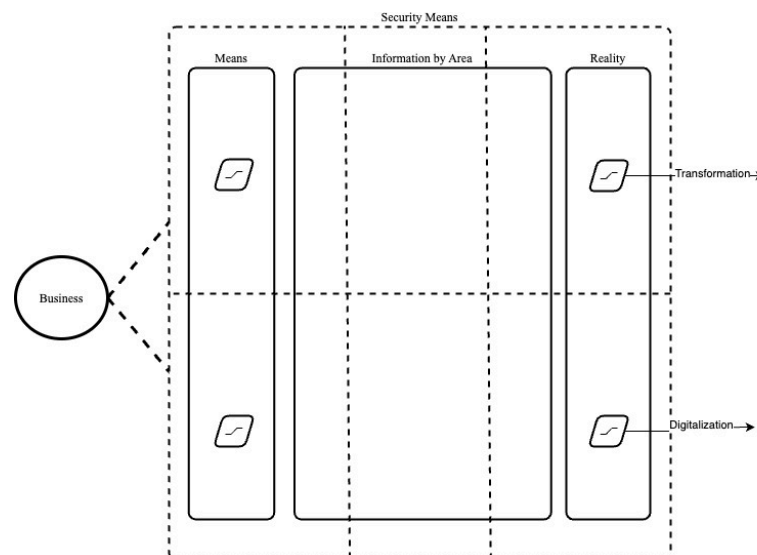


Figure 4 - Analysis by Security

⁸ Limited analysis because has access only the abstract

Thus, we can consider that, from the point of view of security, it can be segmented by each existing part of the entire process separately and or in an interconnected context providing to its limit the "zero trust" model of safety primacy.

4.3 Virtual

In the item proposed after segmentation and the process already explained, the item "Virtual" generated four papers in English obtained from the IEEE Xplore digital library, two of which do not apply to the context of this work.

With the development of digitization to carry out digital transformation, it is proven that greater processing capacity is needed, so the increasingly robust algorithms can perform with satisfactory results [30], [31].

The automation model can be considered digitization because the software is more robust, thus requiring greater capacities of the entire structural network, thus being one of the main requirements of its evolution along with security [31].

You can understand the limit of digitization with the advent of virtualization that requires you to have dynamic and versatile solutions in its configurations AMC⁹, and even locations AWL¹⁰ [31].

4.2.1 Framework to Business Virtualization

As a proposal for the analysis of virtual items, we propose the following holistic framework model from the virtualization perspective by Digital Transformation:

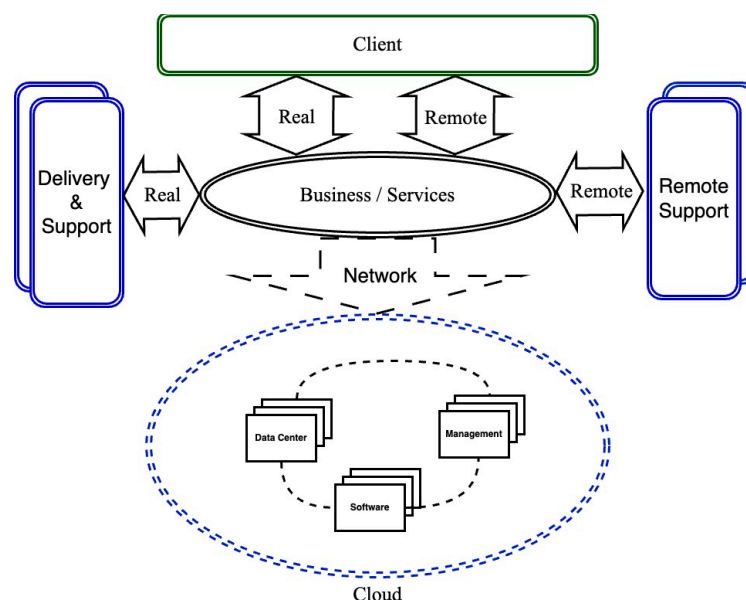


Figure 5 - Analysis by Virtualization

⁹ AMC - Any Mode Configuration - Term developed by the author

¹⁰ AWL - Any Where Location - Term developed by the author

Being the description of the terms of the figure:

Client - Private, Public, Business or Physical

Real - Face-to-face direct access

Remote - Online or offline remote access

Business / Services - Company that provides the service or business

Remote Support - Remote Service. Ex: Sales and/or support call center

Delivery & Support - Delivery, Storage, "on site" support team

Network - Connections between Headquarters and Branches with the Cloud

Cloud - Decentralized service structure of the business structure

This model normally adopted today, is in our understanding as the first phase of virtualization, because the focus is on the virtualization of the business, IT structure, and support and delivery even often digitized continue in the real world.

We can thus adopt a review of the proposal for this model in order to seek Virtual Transformation and so we can later seek to create a neural network of all the elements that impact on the validation and quantification of Digitization and/or transformation, digital or virtual.

In this way, the final model proposed for parameterization can be demonstrated below:

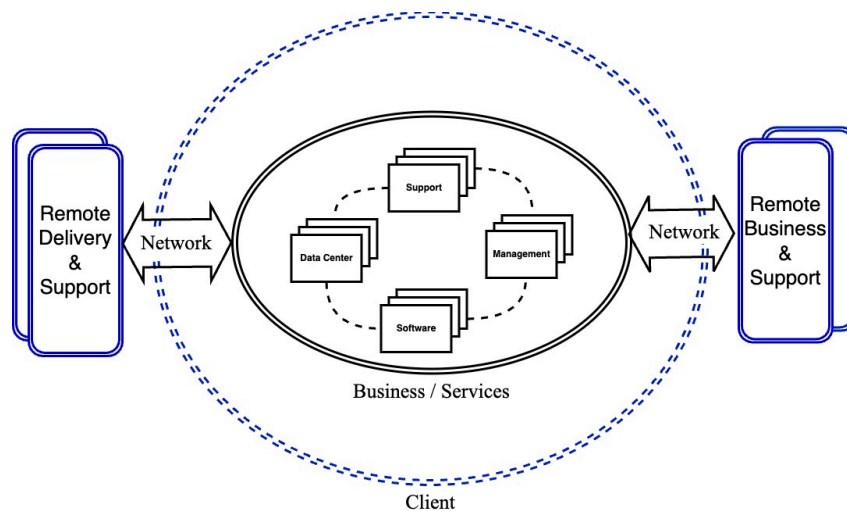


Figure 6 - Virtualization analysis review

In this proposition we can see that virtualization is no longer only in the business, IT structure, but in all phases of the business, transforming it into AnyWhere by AnyOne to AnyClient, thus considering triple virtualization - 3AV.

5.0 Discussion

In the digital transformation we can mention as the "after", because the fundamental concept that we can observe that needs to be a living, pulsating element that can have the ability to adapt and thus change with the variations of external and internal responses [14].

With this, when we observe the evolution of Artificial Intelligence technologies we can realize that the true transformation, or pure transformation will be the virtual transformation, because in its essence there is the evolutionary and adaptive characteristic of its model [15], [21], [31].

With the IoT we can have systems digitization models, or when integrated with an analysis and decision system it can be a determining factor of the degree of transformation in relation to the simple actuator of a digitization [15].

A transformation model needs to have Big Data, which are feasible by the digitization of information, but only with the virtualization of Machine Learning or Deep Learning mechanisms will we have the best use of all the capacity that this data can supply [10].

In a transformation model it must be evaluated that these data can change substantially in behavior and thus the structure learns and reconfigures itself in this new model/set of information [18].

Regarding security, transformation or digitization, it should be an intrinsic factor in all processes, and we can differentiate between the models as below:

- Digitization: security models can be quartered by areas and thus composing a security in a departmentalized way with general standards to meet the business;
- Transformation: security models should be integrated and preferably dynamically so that they can apply the concept of zero risk at any stage of the business, ensuring the same with the dynamics of the business in a "live" way.

5.2 Neural Network Proposal For development

Considering the analyses carried out in this document and in the search to answer the parameters that determine the measurable barriers of digitization and transformation with assertiveness of validation and in the future can be used to evaluate the stages, transformation models we propose the exploded review of the initial workflow object of this work.

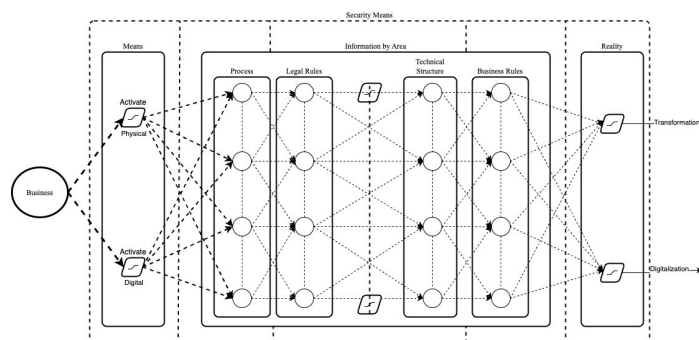


Figure 7 - Initial Propose NNW

Being the description of the terms of the figure:

Business - Any business or service model, and may or may not be limited to use by branch of activity

Means - Physical or Digital

Information by Area - Generated or treated by each existing area, being a non-exhaustive example:

Proccess - Processes or flow of information by each area

Legal Rules - Standards that must be observed throughout the business chain

Technical Structure - Company that provides the service or business

Business Rules - Business or service rules

Security Means - Security by area or interconnected by each connection

This proposal includes the environment, reality, information, areas, and levels of security, and can be general or by segment.

The study and improvement of the interrelationship, as well as activation parameters should be studied, parameterized and modified in a model to be evolved with future work in depth.

6 Conclusion

This work becomes complex due to the need to deepen the proposed themes and models, but even so we can validate that total digitization of an event can even be an initial part of a transformation and because of this, often confused causing loss of competitiveness and consequently of value/interest in the implementation of "pseudo-transformation".

At this stage of analysis we can conclude that the digital "mean" is confused with the virtual "reality", and digitization is a change of "means" and the transformation can be a change of "mean" and/or "reality". While virtualization is the change from the real "reality" to the virtual or change from the "physical" to "digital" means.

It is observed that by the methods that use the digitization of activities, it is nothing more than automation of real processes digitized, and, in virtual reality with the use of AI the processes are already born digital shaping the configurations of real reality.

Thus, we can adopt as a concept to be developed with greater depth in future work:

- Digitization: Automation of processes of the real environment, events, functions and/or activities in time in a sequenced way, which can be continuous or not.
- Transformation: Sub-divide into:
 - Digital: Transform from the physical environment to the digital events, functions and/or activities in time and in a way that has performance in the course of time, constantly shaping the desired output according to the possible variations to occur in the entire chain of execution with or without the AI.
 - Virtual: Automate or Create in the digital environment in virtual reality by AI, processes, events, functions and/or activities in time so that it has action over time, constantly shaping the desired output according to the possible variations to occur in the entire chain of execution.

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