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Policy building through semantics interoperability simulations

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Abstract

This work is focused on the institutional demands related to semantic interoperability, focusing on its social aspects. The main argument presented here is marked by the understanding that public policies of a technical nature that aim at regional integration must consider both the human and social components for their elaboration and application. In this sense, simulations qualified as crisis games integrate a set of methods derived from the methodologies of war games, which can assist in elaborating semantic frameworks of high complexity by testing their application among practitioners of the various political-administrative systems and subsystems. To this end, we use the AJAPT (Agents Joint Assessment Planning Tool) software to develop the analytical framework for testing the semantic building during simulations, proposing an interaction method for integrating semantic interoperability in decision-making processes.

1 Introduction

Semantic systems can be significant for regional integration processes, especially in the face of highly complex dynamics. Considering the various layers in which integration processes must take place, standardisation and protocolisation are key factors. The greater efficiency and relationship between the macro and micro levels of international integration regimes depend on how much the regulatory processes are implemented concerning their compliance.

In diplomacy, agreements demand chain protocolisation, but this does not always consider the social determinants that constitute the bases of integration, constituted by different layers and institutional dynamics (Unceta et al., 2022). Diplomacy is constituted in discourses reflexively related to politics in a way that can be seen as a form of obtaining political significance (Berejikian & Dryzek, 2000; Wæver, 2003; Constantinou, 2013; Holzscheiter, 2014).

This social meaning is characterised by the choices linking normative processes to social creation derived from continuous or intermittent interaction processes within the micro, meso or macro levels (Unceta et al., 2022). No normative processes can exclude the social character of political interactions. In that case, norms will also be applied based on different levels, where society is the primary source as well as the final subject of those norms. Semantic is, thus, a qualifier of norms building and compliance, as norms are dependent on politics. Semantic definitions to guide social interactions cannot ignore incremental social development and the various social uses and understanding behind it.

There are two primary environments, both socially sensitive, in which the imperative of semantic interoperability is based. Often ignored, the first is the abstract environment treated by public policies that have a material, social impact. Social relations can reveal how digital interaction should be driven in this environment. The second is the digital environment, through which the network of semantically interoperable relations is established and where other models of social repercussion reside. Social interactions, then, constitute interoperable models.

The premise of this study is that the project of semantic interoperability within integration regimes such as the European Union is dependent on social interactions. Consequently,

increasing awareness of the various layers of social interaction to constitute the semantic ontologies may benefit compliance. In this case, mechanisms for developing policies associated with semantic interoperability should be guided by mechanisms that enable the experimentation of semantic parameters and ontologies. To this end, simulations are mechanisms of testing and experimentation among practitioners that can leverage policy awareness and work within gaps or misfits relevant to its effectiveness.

2 The social conditioners of the semantic interoperability

There are, thus, two ways of constructing the processes of integration that need to be understood in the light of their social character. The first way is qualified by the processes directed by the macro-political objectives, by which the various sublayers are summoned to adapt. In all ways, the processes built for semantic alignment include public policies that have absolute social appeal.

According to Pan et al. (2007), behaviours are defined as decisions made by individuals based on their instinct, their experience and their bounded rationality. We can consider the individuals as those who move the institutions or the institutions per se once we consider their path and knowledge-building schemes. For the same authors, when it comes to social interactions, those conditioners may shape individual decision-making processes” “through social structures following social identity” s”.

In this sense, it is necessary to note that while diplomatic agreements are assigned, their value chain commonly ignores how much and how these agreements manifest themselves ordinarily. Likewise, the exact agreements are not marked by consultation and social attribution processes as they should. Putrayasa (2017) states that political diversity within diplomatic language is decisive for how perception will be processed in societies. In a later study, Putrayasa (2021) looks for the imbalances between the use of figurative language versus denotative language when it comes to public perception and political language.

Schuurman (2005) makes a study focused on the social qualities of developing semantic interoperability applied to processes in geospatial data sharing. The author identifies three axes that influence semantic interoperability: classification, ontologies and government policies. On the other hand, Fafalios et al. (2021) characterise that data management depends on transcription, consolidation, analysis and exploration. Although conceptually called consolidation, the integralisation of data can only be consoled, according to our premise, from its efficient uses.

Schuurman marks that” “semantic standardisation is, broadly, the problem of calling the same thing different names or slightly different things the same name (“)” (Schuurman, 2005, 49). In continuity, he argues that” “technical approaches would be considerably strengthened by closer attention to institutional practices that contribute to the development of unique communities of discourse – which are subsequently embedded in data semantics” (Schuurman, 2005, 50). As the author warns, technical approaches must be aligned with institutional practices, which should configure the measure of semantic development. This approach is used here from the concept o” “unique communities of discourse” to configure how practices should inform policy.

Pogner (2012) argues that communities should serve the production of knowledge so that the circularity between knowledge and its uses can be continuously nurtured. According to Pogner (2012), the idea of a social dimension is fundamental to the necessary constitution at the level of the concepts between the discourse community and the community of practices related to the construction of knowledge. The characterisation of practices and knowledge through the intersection in the digital technological environment is marked, thus, by hybrid models of political development, practice, and the absorption and formatting of knowledge.

Other relevant studies relate to aligning the needs attributed to technological advances while considering the social constructs embedded in the development of human sciences. This is the case of the experiment related to the use of the European model FAST CAT in the context of the classification of a project related to maritime history (Fafalios et al., 2021).

Pogner (2012) argues that different and characteristic language patterns represent different discursive communities. At the same time, discourse communities affect how members behave or solve problems (Pogner, 2012).

Semantic interoperability is a challenge in terms of information management within institutional agencies and policies. When addressing semantic interoperability, we consider the inherent challenges of collecting, interpreting, and sharing information in a usable and understandable way for different organisational cultures. These challenges have impacted services offered at different levels, from services at a strategic level to the most operational level, since information travels in a bottom-up and top-down flow. (Klischewski, 2003).

The information circulating between actors and agencies goes through linguistic construction, with the cultural element as a crucial factor for reading and analysing data. As Whitman & Panett (2006) states that “the ontology must move beyond just the required technical terms, but should include the cultural and linguistic issues that can confuse the transfer of knowledge”. Systematising information in order to achieve comprehensiveness and understanding, in addition to standardisation of semantic elements, can help institutions in information management. However, it will require flexibility and adaptation to create capacities to increase new informational processes based on appropriate software and technologies for beneficial interoperability.

Building a common vocabulary can be a significant first step towards understanding different actors in integration processes, joint actions, and inter-agency cooperation. Ontological studies have helped in the conceptual construction and the perspective of implementing semantic interoperability with the help of applications or software (Marques, 2018). However, for a robust understanding of concepts, simulations have served as an initial basis for data and information collection, providing subsidies for interaction and semantic integration with the necessary alignment to achieve information qualitative and intelligence to impact the decision-making process in multiple crisis situations positively.

Therefore, the sharing of information can directly impact its result and the decision-making process since the uniformity of information and conceptualisations imply different understandings. In an integrated process of state actions, such as in cases of emergency solutions, public and private actors are widely recognised for helping and seeking efficiency in managing the crisis and working in various domains with high social impact. The ability to solve problems related to national security and defence is among those, including humanitarian assistance in disaster situations, environmental crises and other services that demand interoperability, mainly from the public sector (Marques, 2018).

3 Simulations as instruments for incremental development

Simulation is a concept which has been used to describe testing models that indicate, with a greater or lesser degree of accuracy, the results of interactions among different actors. In general terms, simulations can be used for a wide range of purposes, including predicting the behaviour of a system, identifying potential problems or areas for improvement, testing different scenarios or alternatives, and refining products or processes (Levine et al., 1991, Axelrod, 2007). By creating a simulated environment, researchers, policymakers, and practitioners can gain insights which might be difficult or impossible to observe in the real world.

Imagine that for every doctrine, policy, or law to be effective, it must be embodied in what it means in the ordinary world of institutions. The rules, which serve the best progress of societies, may have coercive instruments that force such learning, but this is not a predominant characteristic. Ergo, simulations can serve as a method of increasing institutions, as well as the rules to which they are related, in an environment of deep and constant interaction, also contributing to the improvement of the decision-making process, as well as predicting behaviours and/or problems in a forecast horizon. (Schutz, 1974; Cunningham, 1984; Johnson, 1999).

Those interested in using a simulation (whether educator, scientist, or practitioner) can make use of a variety of approaches, techniques, and procedures of a qualitative and/or quantitative nature. According to Cunningham (1984), the scientific community and policymakers usually emphasise that the use of simulated exercises tends to be quite effective in the evaluation and observation of different policies, programs, and projects, since such analyses tend to contribute to the optimising decisions when faced with real problems, as well as contributing to the development of predictive analysis and forecasting models.

In the research field of public policy, simulations are seen as a powerful tool to model and evaluate the potential impacts of different policy decisions, helping the analysts to give inputs and assess the outputs of different policies, as well as engage multiple stakeholders in the policymaking process (Schutz, 1974; Cunningham, 1984; Johnson, 1999). Usually, simulations can have the support of computer systems when the indicators are potentially stable and quantifiable. Notwithstanding, in social interactions, complex dynamics or dynamics that cannot be reduced to these models need to be exercised qualitatively. Such qualitative models are focused on experiments on social interaction and the behaviour of actors and on prospecting that mark the results of interactions (Decety & Grèzes, 2006; Pan et al., 2007).

According to Paiva et al. (2020), the premise in which institutions develop through the choices of actors in an incremental manner suggests that policy processes are embedded and can be induced somehow. On the other hand, it is also essential to recognise the effect of bounded rationality (Simon, 2000), which restrains our ability to fully understand and address complex issues due to cognitive and social limitations. The authors suggest that using simulation models that blend quantitative and qualitative elements can be a valuable tool for enhancing institutions, processes, and protocols. Additionally, these models could facilitate the dissemination and the transfer of public policies at a subsequent stage.

By merging both quantitative and qualitative techniques, simulation models can provide a comprehensive understanding of complex systems and processes since this combination allows analysts to cross-reference data, resulting in more robust and methodologically sound inferences. This can enable policymakers to identify potential challenges and opportunities for improvement, as well as test different scenarios and policy interventions. Moreover, simulation models can facilitate the dissemination and transfer of public policies by demonstrating the potential outcomes and impact of a policy change in a tangible way. This can help to build support and understanding among stakeholders and facilitate the implementation of policies in different contexts.

Speculation about possible scenarios is a determinant of policies associated with national security, defence, and doctrine formation among results. The sequence of relationships and interactions with each decision or by interactive decision-making processes qualifies the results. The models produced and used for this purpose, commonly classified as wargames, are used for training and military planning but also ended up having use in the strategic planning of other sectors as political and institutional projection tools.

4 AJAPT as a case study

The Agents' Joint Assessment Planning Tool (AJAPT) is part of a methodology built to facilitate management and the performance analysis of the actors during the simulation of negotiation processes, policy building and scenario estimation. The AJAPT method was formerly named *Performance Analysis Method* (Medeiros, Mendes & Paiva, 2019). Semantic analysis is part of the evolvement of this methodology to permit discourse analysis together with the semantics implications of the negotiations and their outputs.

This article was made so interactions in competitive or cooperative simulations could be partially recorded and analysed. Built-in layers of different roles allow users to connect through specifically assigned teams among designing, managing, analysts, and actors. Thsystem's's primary purpose is to permit coordination and management of a situation evolvement where the behaviour of the actors interferes with the sequence of results. The

interoperability aspect is a driver of the coordination games/simulations when cooperation is determinant.

As so, regime building is comprehended through the various conditioners that mark institutional development. In this regard, simulations serve regime building and are characterised as tools for the institutional development forecast or by testing institutional functioning. The AJAPT tool is aimed at permitting the designing of the appropriate process for coordinating actors' interactions in a way it can permit visibility for decision-making and analysis. As a digital tool, AJAPT is a way to accompany decision experimentation and guide its phases through the insertion of incentives that obliges movements towards the conflict resolution path.

The simulation or game coordinated through the AJAPT is guided by three sequential planning phases where the designers choose the variables to be observed, with eventual sub-variables⁶⁹.

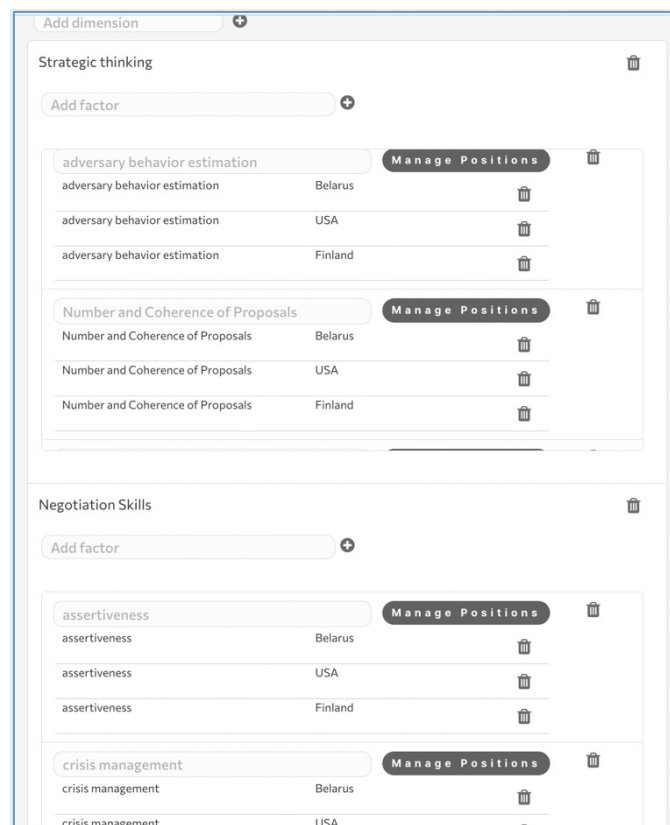


Figure 1. AJAPT: variables are selected as *Dimensions*, as sub-variables are considered *Factors*.

In the second step, the designers register the actors and add their respective representatives in the system so that they can have a specific window to accompany the negotiation processes oriented by the initial case and subsequent incentives driven by the control group, which is formed by the simulation managers. The actors' window is enabled to permit them to message the others, propose a secret strategy, post resolution document proposals, receive information from the control group and plan in a map their eventual operations.

Another window is mainly posed to the registered experts who are going to do the analysis of the actors' decisions. The results of the analysis, both quantified by a previously selected

⁶⁹ The prints of the software used below are derived from a nuclear crisis simulation held by Prof. Jonathan Hall (Uppsala University) and Prof. Sabrina Medeiros (Lusófona University) with students from both universities through the AJAPT.

scale and qualitative analysis, are shown to the control group in its specific screen, as shown below.

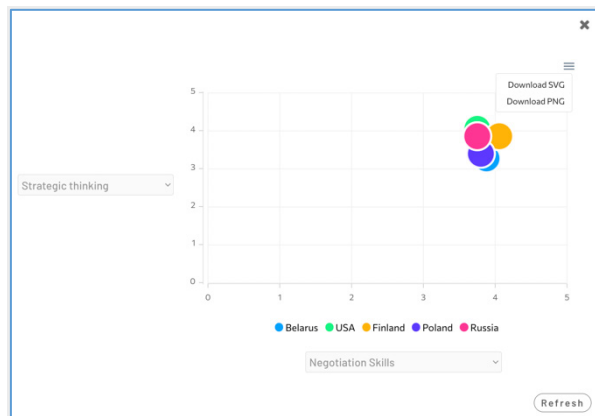


Figure 2. AJAPT: performance analysis results.

The performance analysis is based on the proposed values, scale and variables planned to be applied to each case, such as the willingness to cooperate, the openness to different ideas, the capacity to build solutions, and others. Those attributes are components of the way behaviours are expected to occur in terms of efficiency. The model allows coordination teams (control group and designers) to mark how efficiency should be understood and seen.

On the other side, semantic analysis has been considered in various studies in which discourses are taken as part of the political processes (Neumann, 2002; Constantinou, 2013; Holzscheiter, 2014). To observe the cooperation status with anactors's' engagement, it may be of significance the way actors choose to communicate. That is why the AJAPT is aimed at being incrementally adapted to absorb method changes while permitting research involvement. In its last version (Medeiros, Mendes & Paiva, 2023), the system is designed to permit the control group and the experts to have a semantics statistics window.

Summary Poland

Minimum objectives
 A commitment to peace by all delegations
 No military escalation of the situation
 Maximum objectives
 Improved relationships with participating countries and enhanced cooperation for the future
 Minimum objectives
 A commitment to peace by all delegations
 No military conflict in the Suwalki gap
 Maximum objectives
 Improved relationships with participating countries and enhanced cooperation for the future
 Assurance from Russia Belarus of no military operations in the Suwalki gap

Rank	Word	Score
1	poland	6
2	cooperation	5
3	objectives	4
4	military	4
5	commitment	3
6	nato	3
7	minimum	2
8	peace	2
9	delegations	2
10	situation	2
11	maximum	2
12	improved	2
13	relationships	2
14	participating	2
15	countries	2
16	enhanced	2
17	future	2
18	conflict	2
19	suwalki	2
20	gap	2
21	allies	2
22	delegation	2
23	finland	2
24	escalation	1
25	assurance	1
26	russia	1
27	belarus	1
28	operations	1

Lexical Chains

- minimum
- peace
- delegations
- escalation
- situation
- maximum
- relationships
- belarus, countries, russia
- commitment, cooperation, assurance
- future
- minimum
- peace
- delegations
- gap, conflict
- suwalki
- maximum
- relationships
- belarus, countries, russia

```

"body": {
  "summary": [
    "summary": [
      "Minimum: Guarantee Russia's integrity and security, including it's sovereignty and ability to freely move it's troops and assets through it's territory.",
      "Maximum: Guarantee the freedom Russians in the Donbas, a neutral Ukraine, and prevent escalation of the war."
    ]
  ],
  "lexical_chain": [
    {
      "minimum":
      {
        "s":
        {
          "integrity"
        },
        "ability"
      },
      "troops"
    },
    {
      "assets",
      "garantée",
      "security"
    },
    {
      "territory",
      "russia",
      "ukraine"
    },
    {
      "future"
    },
    {
      "earth"
    },
    {
      "maximum"
    },
    {
      "freedom",
      "sovereignty"
    },
    {
      "russians"
    },
    {
      "donbas"
    },
    {
      "escalation"
    },
    {
      "war"
    }
  ]
}

```

Figures 3 and 4. AJAPT: semantic analysis – frontend and backend.

The method of collecting semantic data highlight the words or concepts of greater relevance and incidence through a word ranking. Secondly, the system aggregates the values accordingly based on an Lexical Chain algorithm. Third, there is also a summary of the ideas based on a natural language processing algorithm. This level of analysis needs to be combined with the qualitative analysis of experts, especially with regard to the significant cooperative or non-cooperative tendencies on the part of actors. The material selected is all produced for the negotiation processes, among them the window for elaborating a confidential strategy, the messages exchanged between actors and the public statements that include the resolution documents and proposed agreements.

We should also note that using multiple languages during policy-building or testing processes marks the challenge of observing how the social-cultural dimension may interfere and how policy can evolve despite this. Semantics is considered one of the possible pieces of evidence to be observed. If the analysis is posed to look at the interoperable conditions, cooperation and trust building are marks that can be found. The negotiation processes derive, as so, a group of indications that can shed light on the tendencies for cooperation and diminishing differences through semantic schemes. Semantic interoperability is both a desired result and a conditioner to the analysis when it comes to simulations that can permit practitioners and policymakers to interact and manifest semantically political cooperation and interoperability viability.

A second level of analysis is under development. Some experiences with semantic analysis have been used to built in a proper tool that can permit the analysis through the AJAPT system. The first selected study is the COH-METRIX method (Graesser et al., 2004), which consists of observing “quality, readability, or other specific properties of written or spoken” terms.⁷⁰ McNamara et al. (2014) developed a method and software used in various scientific analyses. One of the variables used to form cohesion in the method is the density score, in which word rankings characterise incidence. Using proportions or ratios, the density score can tell us what semantic tendencies are expressed in a negotiation. Still, concept clarity is to be developed, and with the diplomatic and negotiation cases, it can bring relevant innovation in the future.

Under the coherence measure, some studies have been dedicated to the lexical chains, where discourse quality is based on the construct of meaning (Somasundaran et al., 2014). Lexical chains are a way to group words connected by their meaning and uses. Although regularly looking at the coherence through the discourses themselves, the meaning of the combined use of concepts is a determinant to the coherence of the discourse. As so, it is a political derivative, as well as semantics can be attached to concepts and individual words. For this reason, we built an algorithm to gather the libraries giving the groups more meaning than individually if connected.

Working for interoperable schemes demands identifying how communication processes are born and as a societal development. Interoperability is a persistent condition and a measure of regime building which is not constant nor static. As policy is reoriented and incremented, adaptive semantic knowledge must be detected (Neumann, 2002; Schuurman, 2005). Thus, this continuing process viability depends on how the political processes absorb adaptability. Those are the ideas behind the choice of incorporating semantic analysis as part of the imprecise ways politics evolves, conditioned by social influence and sentiments.

This includes a significant group of individual choices that reflect collectively and are conditioners of other individual choices in sequence. Rationality is seen as not out of the emotional conditioners that characterise communication. That is why they are all embedded in political schemes such as those under development in an integration regime like the European Union (Decety & Grèzes, 2006; Whitman & Panetto, 2006).

⁷⁰ <https://soletlab.asu.edu/coh-metrix/>

One of the conditions for semantic interoperability is consistency in constructing and formulating information and communications that will directly impact the decision-making process. The proposal for studies about interoperability comes from the fact that this process is surrounded by social and cultural interference, in addition to behavioural aspects of individuals who are inserted in the management of cooperation. Semantic analysis tools have strengthened the understanding of this process and its final result since the rationalisation, planning and operationalisation of these choices are directly related to the way in which the agents involved choose to communicate.

To contribute to the semantic analysis, the COH-METRIX tool (McNamara et al., 2014)) has been studied to become incremental to the improvement of AJAPT, already presented in this session. According to the authors, the COH-METRIX model is easy to understand, using a text box to insert the communication that will undergo semantic analysis. The tool has as a logical construction an analysis first of the words individually, then of the sentences constructed by these words. To finalise the measures of coherence and cohesion, the tool performs the measurement analysis from the complete text. Therefore, methodological perception starts from an analysis of word choices and the way they are arranged in the informative textual construction.

It is possible to verify that the choice of the authors of the COH-METRIX for the priority visualisation by individual words can be related to the use of language with the social and institutional construction of some concepts, which in the whole can be verified, in cases of complex simulation with multiples agencies, including those from different countries. Subsequently, the words organised into sentences and texts complete the interpretation for the players and directly impact the process's decision and cooperative or non-cooperative outcome.

Authors such as Tolk & Muguira (2003) state the need to have techniques for implementing interoperability in simulation systems and establish the model of conceptual interoperability levels (LCIM) to fill gaps in discussions beyond those carried out between specialists and technical human resources (Tolk & Muguira, 2003). For the authors, five conceptual interoperability model (LCIM) levels cover data exchange to documentation consolidation. Level zero of conceptual interoperability based on specific data, level 1 on documentation of data and interfaces, level 2 is aligned with statistical data of data management, therefore, on repetition and standard ontologies, level 3 the dynamic proposition of data, and level 4 by the data harmonisation process that will bring semantic consistency to a standard conceptual model.

The studies of semantic interoperability methods and tools help us to expand and evaluate the new methodological and technical insertions in the AJAPT software. In this way, some objectives follow here as a proposal to verify in the simulations the ability to communicate and share information that can help in decision-making in complex situations. Making data accessible, performing information management, configuring the already processed information more understandable and reliable, and allowing interoperability according to the needs of users, are among those objectives.

5 Conclusions

The benefits of associating simulations with the integration programs of regional regimes reach both the technical character of normative experimentation and the possibility of increasing public policies based on experiences.

For an inter-organizational process to be efficient and successful in its results, we can consider that relationships must start by sharing information capable of generating intelligence and providing the necessary support for collective actions in the public sector. Inter-organisational collaboration and coordination are currently established in a network model so that interaction and data integration remain even if one of the actors has left this process. For the information to circulate in order to meet the needs of the decision maker in order to solve complex problems in a short time, we need to develop methodologies, techniques and use of software to quantify and qualify the information, avoiding errors, allowing the storage of data and information and building models of semantic interoperability that deal with the plurality of organisational cultures.

Simulations are models implemented by specialists observing the specificities of the problems to be solved, the objectives to be achieved, the benefits for public policies, the maturation of organisations in a complex and interagency environment, building trust and good practices and by sharing and a better understanding of the information. Simulations are, therefore, didactic mechanisms for empowering and training individuals and their institutions to work collectively and cooperatively to provide a better service, achieve a better response process and end up with positive results.

In this regard, one of the biggest challenges is inserted in the different mindsets and cultures that often need to collaborate in adverse situations, building consensual and collaborative decision-making parameters based on the understanding and role of each individual or agency, in addition to needing to understand the language and the information offered to them. Semantic interoperability thus becomes one more factor to be improved by methods and techniques that can be trained by means of simulations and applied in software such as AJAPT.

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