Value Creation Through Collective Intelligence: Managing Intellectual Capital

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Abstract: The contribution of intellectual capital to value creation beyond individual companies into wider society, as described in the fourth stage of intellectual capital research, is of particular relevance for the public sector where organizations have a stewardship responsibility. They should engage stakeholders into value co-creation by developing organizational and ecosystem collective intelligence through traditional as well as innovative tools such as online technologies. Yet, the relationship between intellectual capital and value creation often remains a relatively unexplored process within public administration. This paper focuses on the case study of a regional agency in Friuli Venezia Giulia, Italy, which is not only responsible for assistance, regulation and service delivery, but also for engaging its stakeholders and the public at large to disseminate knowledge to promote values and appropriate behaviour in the policy areas it is responsible for. The research looks at the role played by intellectual capital in the agency's value creation strategies and how the agency's structure and processes influence the development and management of intellectual capital in an effort to create value for its ecosystem. The research not only validates the existence of ecosystem frameworks in public administration and the key role played by intellectual capital in their design, creation and implementation, but it also highlights the need in the public sector for a defined role for intellectual capital, stakeholder engagement and collective intelligence in governance models. In particular, findings underline the need for new intellectual capital management systems based on a collective intelligence approach within multi-stakeholder co-creation frameworks in a public service ecosystem logic, reflecting the public sector's evolving role and the new tools developed with the advent of new technologies.

Keywords: ecosystems, public sector, public value, stakeholders, value co-creation, social media

1. Introduction

This paper explores how public entities can foster value creation in their communities by promoting intellectual capital (IC) development and stakeholder engagement. The ability of a community to carry out a task or solve a problem more effectively and efficiently through collaboration and knowledge sharing has been defined as "collective intelligence" (Leimeister, 2010; Malone, Laubacher and Dellarocas, 2010) or "wisdom of crowds" (Surowiecki, 2004). It implies that large groups can achieve better results than any single individual in a group because of the diversity, independence and working together of their members. In other words, individual and distributed assets and expertise can be coordinated into a collective framework which can support organisational and governance structures, connectivity patterns or platforms in improving the flow of information and resources within ecosystems to achieve a collective, yet not necessarily consensual, goal (Secundo et al., 2016). Internal stakeholders contribute with their individual intelligences to the collective intelligence of an organization, while both internal and external stakeholders contribute to the collective intelligence of an ecosystem. These shared or group intelligences that emerge from the collaboration and competition of many individuals go beyond the sum of individual intelligences into an integrated collective intelligence (Bratianu, 2018), which is today applied in many fields from sociology to business management, from computer science to communication (Secundo et al., 2016). As collective intelligence leverages IC sharing within the wider society, a collective intelligence approach based on with IC and stakeholder management can support public organisations in improving the quality of their services and in creating public value in their ecosystems (Borin and Donato, 2015) by bridging internal and external knowledge (Rossi and Magni, 2017).

This study aim's is to appreciate whether and how IC can be managed to increase a public agency's impact on society through the perspective of collective intelligence. To achieve this, we implement a practical framework and qualitatively explore the case study of ARPA FVG through documental analysis, a review of online media and in-depth interviews. ARPA FVG is the agency for the environment of the Friuli Venezia Giulia (FVG) Region in north-eastern Italy. It is an interesting case study since, as an environmental regional agency, ARPA FVG is not only responsible for assistance, regulation and service delivery, but also for engaging its stakeholders such as

local authorities, regional firms, industry associations, schools and the public at large to disseminate knowledge to promote standards, principles and appropriate behaviour in the policy areas it is responsible for. Hence, the research looks at the role played by IC in the agency's value creation strategies and how the agency's structure and processes influence IC and its management in an effort to create value for its region.

The paper is divided into six sections. This introduction is followed by a literature overview which explores IC, ecosystems, public value, service logics and value creation and co-creation and sets out the research question. The research framework and methodology are explained next, while the following sections provide some insight and a discussion about how IC is managed within the regional agency chosen for this research. The last section offers some remarks about the potential of IC management for fostering value co-creation through developing collective intelligence within a public service ecosystem logic.

2. Literature overview

Adapting a definition used by Stewart (1997), IC can be understood as material, knowledge, experience, intellectual property, information that can be used to create value (Dumay, 2016). Some authors have noted, however, that IC is not a stock but rather a dynamic entity, which is not the result of a sum of intangible assets, but rather of their integration to create value (Bratianu, 2018).

IC research has evolved (Guthrie et al., 2017) from an initial stage where scholars focused on raising awareness of why IC was relevant as a means to create, develop and manage competitive advantage (Stewart, 1997; Petty and Guthrie, 2000) to a second stage where specific tools used for measuring, managing and reporting IC and its dimensions of human capital, relational capital and structural capital were designed (Guthrie, Petty and Ricceri, 2006; Boedker, Mouritsen and Guthrie, 2008; Ricceri, 2008). A third stage has been characterised by studies that critically examine IC in specific contexts (Dumay, 2009; Giuliani, 2009; Guthrie, Ricceri and Dumay, 2012; Chiucchi, 2013). These studies have led some authors to emphasise that when analysing organizational IC it is not sufficient to investigate its three traditional dimensions, but also their underlying components need to be appreciated. These are rational capital, which stems from explicit knowledge, emotional capital, which is about trust and other feelings, insights and hunches that are needed for a system to operate and can be used, for example, to motivate actors, and spiritual capital, which is about the moral judgements and values which work as a reference system in making decisions (Bratianu, 2018; Bratianu and Bejinaru, 2019). Furthermore, the rise of the knowledge economy and the increasing importance of networks and collaborative efforts (Edvinsson, 2013) had a relevant impact on IC research and perspectives creating a fourth stream of research (Guthrie and Dumay, 2015): scholars have recognised that, on the one hand, the presence of an adequate social, environmental, cultural and informational context or "ecosystem" is fundamental for IC to create, develop and generate value for an organisation and its stakeholders (Borin and Donato, 2015), while on the other IC has been identified as a crucial factor for understanding how ecosystem value is created, i.e. as a driver of the ecosystem economy (Ståhle and Bounfour, 2008; Bounfour and Edvinsson, 2012) and as an innovative force (Mercier-Laurent, 2011).

Value creation is indeed more relevant to the public sector than wealth creation (Guthrie et al., 2014), because it promotes economic utility, social worth and environmental value. The concept of value in public settings is particularly complex, elusive and widely debated (Petrescu, 2019), so much that the literature reflects numerous definitions of public value (Best, Moffett and McAdam, 2019) and its conceptualisation, management and measurement remain ambiguous and contested (Bracci et al., 2019; Moore, 2014). Yet, value creation has been defined as the increase or transformation caused by an organization's activities and outputs to private and public assets, that is the organisation's and its stakeholders' capitals (IIRC, 2016). Moreover, recent contributions recognize stakeholders, (that is clients, suppliers, employees, etc.) as arbiters of public value (Prebble, 2016): not only their different perceptions of what constitutes value (Benington, 2009) are relevant (Hartley et al., 2017), but also value is co-created through the interaction of multiple stakeholders in a "service ecosystem" or "value network" (Lusch, Vargo and Tanniru, 2010). Value is co-created through balancing the diverse interests of multiple stakeholders who have different value propositions, roles, and attributes of salience (Best, Moffett and McAdam, 2019). Value co-creation is at the basis of the public service logic (PSL) (Osborne, 2018) which was developed from the service dominant logic (SDL) (Vargo and Lusch, 2004). According to SDL, service is the basis of exchange, that is an intangible and process-based delivery, and it represents the application of different competencies, including knowledge and skills, by one party to benefit another (Petrescu, 2019). The objective in SDL is to recognise users as co-creators and to maximise their involvement in the customisation of the

offerings (Vargo and Lusch, 2004, 2016). When considering public services, the specifics of public management made it necessary to adapt SDL to PSL in three ways. First, value is not only created and also evaluated by user, i.e. citizens, who can assume different roles, as clients, volunteers, controllers, and collective citizens (Grönroos, 2011; Osborne, 2018), contributing to the delivery process with different resources that include knowledge, energy, time, assets, compliance, ideas, and legitimacy (Loeffler and Bovaird, 2016), that is with physical, financial and intellectual capital. Second, if applied to public services, SDL recognizes all stakeholders, not only users, as co-creators becoming a resource and playing an active part in the service provision process (Petrescu, 2019). Public service ecosystems incorporate all the individuals and institutions involved in the creation and delivery of value generated through the public system and its stakeholders. Third, PSL emphasises the need for public services to focus on external value creation rather than internal efficiency alone (Osborne et al., 2015). Hence, PSL is about value co-creation, that is the generation of value both for service users and for society in direct and indirect interactions between organisations and all their stakeholders (Osborne, Radnor and Strokosch, 2016; Petrescu, 2019). Interactions among stakeholders occur at different levels, such as the individual, the organization and the ecosystem or network referred to also as the micro, meso e macro levels (Bryson et al., 2017), and at different stages of the overall service delivery process, for example resource acquisition, service delivery or service evaluation. It should be also taken into account that public services are often managed and delivered by private or third sector organisations (Broadbent and Guthrie, 2008), so much that stakeholder engagement is often an implicit necessity. Considering the multiple levels and stages at which stakeholders interact, the delivery of public services may foster IC development and create value at the micro, meso, and macro level throughout the service delivery process.

In order to foster such interactions, public sector organizations have had to innovate, resulting in the removal of silo attitudes to embrace more collaborative approaches offering the potential for greater value at different levels through exchanges of resources such as knowledge, skills and experiences that benefit their ecosystems (Best, Moffett and McAdam, 2019; Osborne, 2018; Vargo and Lusch, 2016). Stakeholder engagement has been recognized as a key element for an ecosystemic approach in many sectors and especially for public organizations (Secundo et al., 2016). Indeed, in general the public sector is a primary example of how IC transcends the scope of a single organisation: public bodies are not only responsible for specific service delivery, but they also have a stewardship responsibility (Osborne, 2018): they are responsible for creating public value through fostering the enhancement of IC at systemic level (Dumay and Garanina, 2013; Guthrie et al., 2017). In other words, they can lead IC development efforts encouraging the development of collective intelligence (Leimeister, 2010; Malone, Laubacher and Dellarocas, 2010).

Yet, despite the recognized importance of collective intelligence and public organizations' leading role, little empirical evidence has been collected on these processes for the public sector (Guthrie, Ricceri and Dumay, 2012; Dumay, Guthrie and Puntillo, 2015; Guthrie and Dumay, 2015). This paper aims to contribute to this research gap and to further investigate IC in public entities as IC management changes to incorporate an ecosystem perspective with a collective intelligence approach and to encompass the public sector's evolving role. Therefore, our research question is:

How can public organizations foster collective intelligence to create value?

This main issue about collective intelligence is underpinned by two sub-questions that are:
How do public organizations manage IC to create value?
How do public organizations engage stakeholders to create value?

3. Research framework and methodology

In order to appreciate if and how IC is managed within a public organisation this paper employs a framework used for analysing IC management and collective intelligence in other public contexts in Italy: the analysis has been carried out using the collective intelligence "building blocks" developed by Secundo *et al.* (2016 and 2018). Such framework highlights IC management as a collective intelligence genome (Malone, Laubacher and Dellarocas, 2010) through the key questions of "what", "who", "how" and "why" (Secundo et al., 2018), where:

- "What" outlines the mission, that is the goals, of an organisation;
- "Who" represents its human capital, that is internal and external stakeholders who collectively contribute to its mission;
- "Why" includes the vision of an organisation and outlines the aims and motivations behind IC management that are relevant to its mission;

- "How" includes a set of processes and actions to achieve such mission and vision by promoting IC.

A case study methodology has been implemented because it allows researchers to answer how or why questions about a contemporary set of events which the researcher has little control over (Yin, 2014) through uncovering nuances, patterns, and latent elements (Lune and Berg, 2017). In selecting the subject for the case study, ARPA FVG was chosen because it is a public agency with a remit to engage its stakeholders and create value for its region, hence it is a case where the process of interest should be easily observable (Eisenhardt, 1989).

The researchers first developed a research protocol which included the research questions and required multiple data sources (Eisenhardt, 1989; Yin, 2014), that is ARPA FVG's key strategic and performance documents, its websites, Facebook pages and Twitter accounts as well as its senior managers. It was necessary to analyse also the IC content disclosed online, since formal evidence was not regarded as sufficient. Undeniably, an analysis of formal documents, arrangements and procedures is not anymore sufficient to appreciate the full extent of resources, structures and processes available to an organization to create value (Dumay and Guthrie, 2017). Developments in technology, Big Data and the way society communicates are shifting disclosure practices from traditional media to online channels such as websites, Facebook and Twitter (Massaro, Dumay and Bagnoli, 2017; Ndou et al., 2018). Online media, such as websites and platforms like Facebook or communication tools such as Twitter, can be used as rich sources of information and viable channels for disclosing IC. Indeed, on the one hand online tools have created new opportunities for organizations not only to disclose their IC information to stakeholders in a timely manner, but also to gain relevant insights and feedback into their impact on their ecosystem and to engage stakeholders in furthering opportunities to co-create value. On the other hand, IC is often disclosed by individuals in informal settings and through informal and even unintended channels such as the social media (Cuozzo et al., 2017; Massaro, Dumay and Bagnoli, 2017; Ndou et al., 2018).

Data was collected between October and December 2018. Initially, the 2015-2017 guidelines, the 2016-2018 strategic plan, the 2017 performance and management reports, the 2018 annual programme and the 2018-2020 programme were reviewed to extract the main processes, strategic objectives and actions for achieving the agency's vision and mission. At the same time, the agency's website, Facebook pages and Twitter accounts were monitored to appreciate the depth of IC that was being disclosed and shared beyond the periodic online reports and statements which are mandatory and regularly published also online. Results were then discussed with senior managers during in-depth interviews in order to triangulate the data, corroborate initial findings and ensure construct validity.

4. The case study: ARPA FVG through the lenses of collective intelligence

ARPA FVG was established in 1998 merging four provincial hygiene and protection units into a regional environmental agency. In 2015 a new Director was hired and over the past four years ARPA FVG has managed a major transition and has invested heavily in its infrastructure and resources, while reporting an operating profit.

This section provides an analysis of ARPA FVG IC management in the last four years following Secundo *et al.* (2018)'s collective intelligence framework. Figure 1 shows how such scheme has been applied to the regional agency selected as case study.
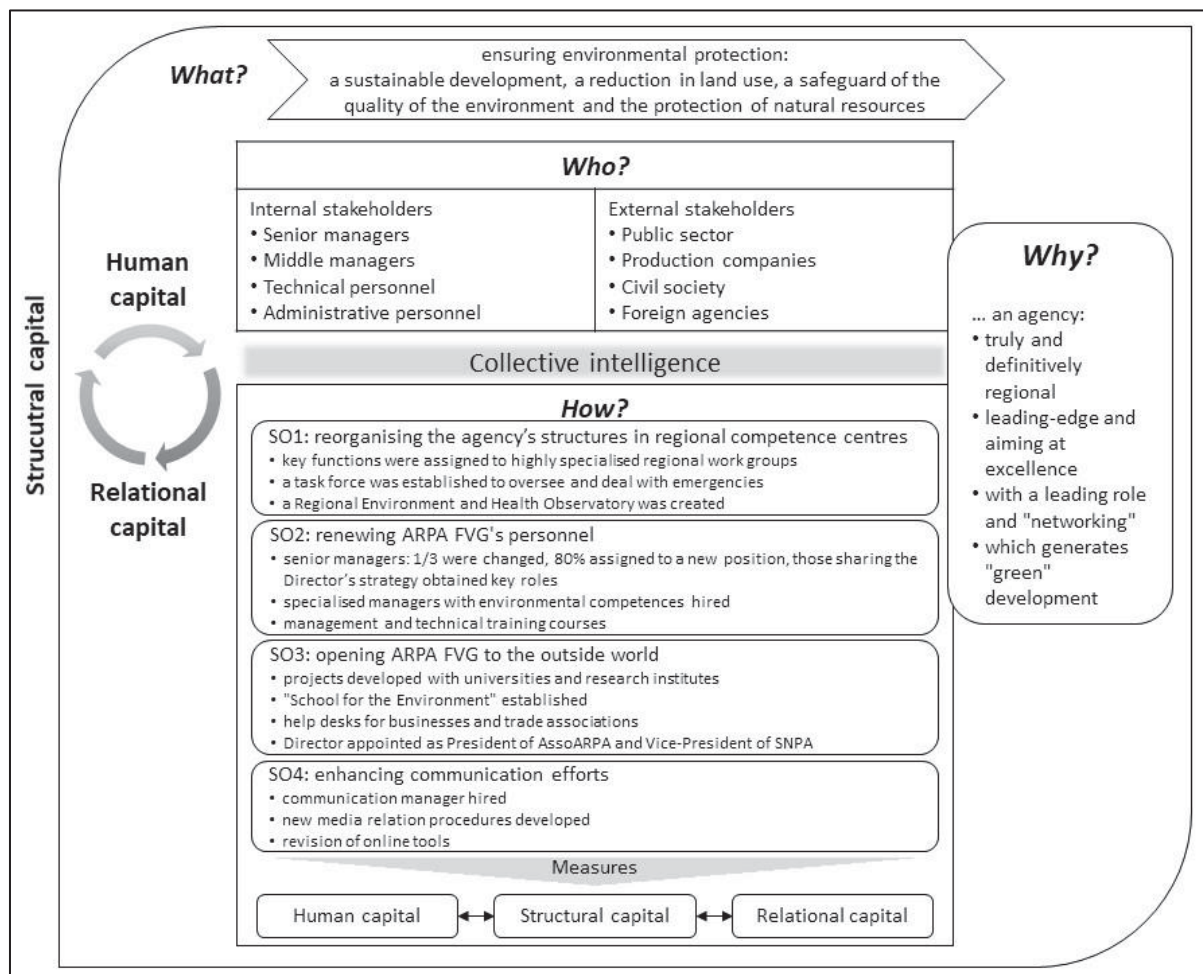
Figure 1: The framework for IC practice at ARPA FVG using the collective intelligence approach - adapted from Secundo et al. (2018)

4.1 The what element: ARPA FVG's mission

ARPA FVG was established as the FVG regional agency responsible for functions and technical activities related to environmental monitoring and control, for carrying out research and scientific support activities, as well as for the provision of both environmental and health-related tests and analyses. The law instituting it mentions 22 different services ARPA is responsible for and nine main business areas, that are air, water, land, waste, noise, radiation, industrial risk, weather forecasting and an educational laboratory.

ARPA's mission has evolved over time to include new responsibilities in line with the development of environmental regulations. In recent documents such as the 2017 Management Report ARPA FVG's mission is thus summarised as "ensuring environmental protection and pursuing the objectives of a sustainable development, a reduction in land use, a safeguard of the quality of the environment and the protection of natural resources through the following functions: monitoring the state of the environment; controlling pressure factors; disseminating data and producing knowledge on the state of the environment and on its pressures; offering scientific-technical support to public decision making; producing information and implementing environmental educational and training programmes." Strategic documents aim for ARPA FVG to become a key player in the National System for Protecting the Environment (SNPA), a network of all major stakeholders involved in environmental issues, and in AssoARPA, the association of regional environmental agencies in Italy. The Director of ARPA FVG is the current Vice-President of SNPA and President of AssoARPA.

Given these prominent roles, ARPA FVG represents a critical case (Yin, 2014) that could help challenge and extend existing knowledge for the fourth stage of IC research or it could at least serve a revelatory purpose (Yin, 2014).

4.2 The who element: ARPA FVG's stakeholders

Public sector organisations work in a unique context and their stakeholders differ significantly from those of the private sector because their relationships with external stakeholders are an important factor when considering their impact on society (Best, Moffett and McAdam, 2019; Massaro, Dumay and Garlatti, 2015; Petrescu, 2019; Secundo et al., 2018).

ARPA FVG has over 300 employees (senior and middle managers, technical and administrative personnel) among its internal stakeholders and many external stakeholders who can be grouped into major categories as shown in Table 1.

Table 1: External stakeholders

Stakeholder category	Major stakeholders and aim of their involvement
Public sector	FVG Region: institutional activities and through ad-hoc agreements Ministry for the Environment, SNPA: information exchange and implementation of directives Courts and law enforcement agencies: checks and opinions Healthcare agencies: laboratory tests and analyses Local authorities: checks, giving opinions on monitoring activities, other activities through specific arrangements Universities, research centres, schools: environmental information and education, cooperation on environmental projects
Production companies	Suppliers: purchasing equipment, raw materials and services Regional firms: checks, tests and environmental information
Civil society	Public bodies, private entities, associations: communicating environmental information Citizens: ARPA FVG checks and informs, citizens file complaints and request environmental assessments
Foreign agencies	Environmental agencies of border countries (Austria, Slovenia and Croatia): supporting activities for environmental agreements, cooperation on environmental projects

Source: 2016-2018 Strategic Plan and interviews

ARPA FVG works in close relationship with public and private entities as well as associations and individual citizens in order to collect data to support environmental monitoring, offer technical support and compile environmental assessments. Working on the ground means moving daily throughout the FVG Region in order to take samples, visit companies, participate in activities to support authorization, certification, information and control processes.

However, during the interview the Director recognised that one of ARPA FVG's Achille's heels is its weak relationship with individual citizens and businesses. The agency has not yet "engaged society at large; we rather deal with local authorities, schools and trade associations from a position of authority". Moreover, the agency's uses of social media to share its IC is rather limited. They do not use their website or social media pages for engaging their stakeholders, but rather as a one-way dissemination tool to communicate environmental information, news and alerts in a timelier manner that other media often allow. Yet, at a time when trust in scientific knowledge and evidence is dwindling, it would be important for public agencies to find a way to engage citizens and entrepreneurs while fulfilling their role without shirking their responsibility.

4.3 The why element: ARPA FVG's vision

In 2015 after a listening and confrontation period of a few months, the new Director developed together with the Region and key senior managers within ARPA FVG the 2016-2018 Strategic Plan which outlined a new vision for the agency. According to the Plan, in order to focus its activities, its processes and its staff to achieve its mission, ARPA FVG should become an agency:
- truly and definitively regional,
- leading-edge and aiming at excellence,
- with a leading role and "networking",
- which generates "green" development.

This new vison was widely publicised through both traditional and online channels in reports, slogans, conferences and videos.

4.4 The how element: ARPA FVG's strategic objectives and actions

Managing IC allowed ARPA FVG to pursue its mission and vision. The four elements of ARPA FVG's vision can be roughly referred back to the components of IC and to the generation of public value as follows:

- A truly and definitively regional agency can be supported by the development of its structural capital, that is by organising its processes and structures on a regional rather than provincial or municipality level.
- A leading-edge agency aiming at excellence can benefit from investing in its human capital, that is through the selection of highly competent employees and from training programmes on new technical competencies and management practices.
- An agency with a leading role and "networking" can be fostered by the enhancement of its relational capital, that is advancing its relations with and beyond its external stakeholders.
- Lastly, an agency which generates "green" development is an organisation which contributes to its ecosystem by generating public value.

Between 2015 and 2018 under its new Director, ARPA FVG developed several strategic objectives in order to manage its IC so as to pursue its mission and vision. The specific actions implemented for each strategic objective (SO) are outlined in the following sections.

4.4.1 SO1: reorganising the agency's structures in regional competence centres

ARPA FVG was born out of provincial environmental departments with units, laboratories, and so on duplicated across the four provinces of the FVG Region. The aim of this SO was to substitute the old provincial division with regional competence centres in order to harmonise behaviours and services, improve efficiency and raise working standards. Among all actions undertaken to achieve this, many were infrastructural but three aimed specifically at developing ARPA FVG's structural capital: rather than being duplicated across four provincial offices, key functions were assigned to highly specialised regional groups which developed new procedures for the entire Region; a regional task force was established with special provisions to oversee and deal more flexibly with environmental emergencies; lastly, a Regional Environment and Health Observatory was created to bring together environment and health-related issues rather than having to rely on local and regional healthcare structures.

While these actions helped develop ARPA FVG's IC, particularly its structural component, they were imposed from the agency's management team rather than decided with the engagement of internal stakeholders. Interviews revealed that managers preferred to implement quickly the new model they had agreed upon with regional authorities, rather than invest, for example, in lengthier participatory activities with employees. This did not help the development of emotional capital and spiritual capital within ARPA FVG: employees did not develop much trust towards managers who had not involved them in the new developments and this did not allow shared values to develop.

4.4.2 SO2: renewing ARPA FVG's personnel

ARPA FVG has always been a flagship for the FVG Region. Yet its new Director aimed at aligning it to the highest national and international technical and administrative standards by investing in its human capital.

Between 2015 and 2018 a third of senior managers were changed and 80% of those who remained were assigned to a new position with those sharing the Director's strategy obtaining key roles. Moreover, older managers and technicians had mainly a background in traditional fields such as medicine, chemistry, physics and biology; when they retired, they were replaced by younger highly specialised ones with the latest environmental competences. Lastly, training courses were organised focusing both on management and technical issues, so that employees would both learn new working practices and acquire cutting-edge know-how and skills. This developed human capital especially in its rational component.

However, once more, these activities were imposed rather than shared involving internal stakeholders. ARPA FVG's management team maintained that they first needed to invest and train their human resources to

overcome their old and compartmentalized mentality before they could involve them effectively in staff reorganization efforts. Yet, another occasion was lost to enhance emotional and spiritual capital.

4.4.3 SO3: opening ARPA FVG to the outside world

In order to create more synergies with its external stakeholders and to make ARPA FVG an environmental point of reference for its ecosystem, more opportunities for cooperation were created. In particular, several environmental projects were developed with universities and research institutes, a "School for the Environment" was opened to train business managers and entrepreneurs on the latest environmental regulations, risks and control procedures, help desks were established in the four largest cities as listening and interaction contacts for businesses and trade associations, and some "citizens science" projects were implemented. For example, recently, ARPA FVG set up a project involving 1000 households on the radioactivity risks of radon. While the project was mainly a one-way information effort which did not actively engage external stakeholders, it was considered a success because more citizens participated than initially hoped for and because at the same time key data were collected, information was provided to people who do not belong to ARPA FVG's traditional target groups and the process helped rebuild trust in public agencies. Hence, in this case, beside developing the rational component of external stakeholders' human capital, ARPA FVG managed to develop partly the emotional and spiritual components of its human and relational capital, even though participants' online feedback reveals that more could have been achieved if they had been actively engaged.

Moreover, the appointment of its Director as President of AssoARPA and Vice-President of SNPA has brought ARPA FVG at the centre of Italian and European environmental networks and has made it a point of reference for the Italian Ministry of the Environment, allowing ARPA FVG to be involved and even lead procedural and regulatory changes.

4.4.4 SO4: enhancing communication efforts

A communication manager was hired and new media relation procedures established in order to disseminate and publicise ARPA FVG's activities and news. This should improve the awareness of ARPA FVG, its activities and its services across and beyond the FVG Region and it should also help promote ARPA FVG as an authority in environmental matters. It is important that ARPA FVG is respected as an eminent and independent body rather than being perceived as an instrumental body linked and dependent on the regional government, its policies and programmes.

In particular, ARPA FVG's online tools have been revised to fulfil different tasks. Its website was given a new outlook: it both provides corporate information, such as its mission, its vision, its key people, its periodic reports, news and achievements, as well as it offers news, guidelines and databases for its nine main business areas. Twitter accounts were created at corporate level and for the air and weather forecasting units to communicate respectively corporate news, brief air monitoring bulletins for traffic restriction, and weather alerts. Mobile applications are available to monitor air and water pollution, as well as waste collection. Its weather unit also has its own website, FaceBook page and mobile application to inform about daily and weekly forecasts. Its educational laboratory has its own website and FaceBook page to promote its events and activities and its own YouTube channel to post its conferences and educational videos.

Overall, ARPA FVG's websites and FaceBook pages are well-managed disclosure channels that publish information not only about the organisation and its business area, but also about their new and innovative initiatives and their achievements in a timely and dynamic way. However, interviews revealed that social media efforts are still at their infancy. Online tools have been designed to inform society, but little resources have been devoted to studying how to better use them to disclose IC and engage stakeholders. Hence, rational, emotional and spiritual capital could have been further enhance by involving stakeholders more actively.

5. Discussion: IC management and collective intelligence at ARPA FVG

In applying a critical approach to discuss how IC management at ARPA FVG has fostered value creation through developing collective intelligence within its organization and its ecosystem, it is important to go back to the main theoretical tenets outlined at the beginning of this paper and to the research questions to appreciate how a public organization such as ARPA FVG manages IC and engages its stakeholders to enhance collective intelligence and create value.

First, IC is an intangible resource for an organisation as well as for its ecosystem (Ståhle and Bounfour, 2008; Mercier-Laurent, 2011; Bounfour and Edvinsson, 2012; Borin and Donato, 2015). And yet, no formal statement of either intangible resources or IC as such is mentioned in any of ARPA FVG's documentation. This indicates little formal awareness of the concept and, presumably, of its potential. Yet, its senior management mentioned repeatedly the importance of IC dimensions in the strategies and actions they implemented from 2016 to 2018: they invested heavily in human, structural and relational capital. Hence, there is no formalisation of IC management structures or procedures and yet its dimensions are recognised as an important resource for the organisation: ARPA FVG manages IC to create value for itself and its ecosystem, but it does so offhandedly without clearly disclosing IC objectives, procedures and arrangements.

Second, collective intelligence describes a phenomenon where, under conditions of diversity and independence, large groups can attain better outcomes than any single individual by pooling, processing and integrating individual contributions in collective outputs (Secundo et al., 2016). In this respect, IC contributes to value co-creation engaging stakeholders themselves in creating value (Rossi and Magni, 2017). Moreover, online media tools and Big Data have created new opportunities for fostering IC and value co-creation (Ndou et al., 2018), since they allow the instantaneous creation and exchange of information as well as interactive communication and relationships among stakeholders (Dumay and Guthrie, 2017). However, at ARPA FVG, on the one hand the people involved in achieving its mission and working towards its vision are a restricted group of people, a "hierarchy". There has been little attempt to engage stakeholders at different levels and stages with no appreciation, let alone procedure on how to manage their different and often competing priorities (Malone, Laubacher and Dellarocas, 2010; Secundo et al., 2016; Bryson et al., 2017). On the other hand, the agency's use of social media to share its IC is rather limited. Apart from designing new websites and apps which provided updated information about weather and environmental news and alerts, little has been done to understand key issues about online media and Big Data such as the types and amount of IC being disclosed whether intentionally or unintentionally, the extent to which non-traditional tools are used for disclosures, the timing of disclosures and the needs of stakeholders (Ndou et al., 2018). In general, the emphasis seems to be on investing in rational capital (training, information sessions, promotional campaigns, online news, etc.), neglecting IC's emotional and spiritual components, that would require, for example, investing in internal and external stakeholders' actual participation in decision making and production processes.

Overall, findings underline a certain authoritarian, if not paternalistic, approach. All documents talk about stakeholders as "users served" by ARPA FVG, which signals a unilateral relationship, which is not what a collective intelligence approach would envisage for an ecosystem in which everybody contributes and co-creates towards a common goal. The Director himself mentioned that they have tried to move away from a "command & control" logic to a more collaborative approach. Yet, more can be done as they still tend to simply tell businesses what to do to comply with environmental regulations and then check they had done it. The authoritarian stance often taken by public agencies and the passive role played by citizens, associations and businesses do not adhere to the collective intelligence criteria of IC stakeholder engagement developed by the fourth stage of IC research (Guthrie and Dumay, 2015).

Therefore, notwithstanding its recent changes, ARPA FVG appears still more a regulator and service provider than a public value promoter. Yet, IC management could improve within the organization and expand beyond the agency's boundaries. In other words, ARPA FVG could become a catalyst and accumulator of organizational and ecosystem collective intelligence by effectively placing itself at the centre of the regional ecosystem for environmental issues. Its Director appreciates that ARPA FVG in order to deliver public value cannot count only on its own resources but needs to look beyond its organizational boundaries. According to him, the complexity of management stems precisely from integrating and building value through external resources. Hence, a future objective for ARPA FVG could be to develop and implement an IC management and stakeholder engagement plan in order to create value for its organization and its ecosystem. A more systemic perspective would suggest engaging internal and external stakeholder by investing more in emotional and spiritual capital to create trust, support and shared values within and outside the organisation. Engaging internal stakeholders by allowing them to actively participate in decision-making processes could facilitate the development of organizational collective intelligence from individual intelligences. Similarly, creating more interaction among internal and external stakeholders and engaging them through their active involvement in production processes would promote ecosystem collective intelligence. This is a much more ambitious proposition than simply delivering assistance, regulation and services, and it is fully in line with the tenets of ARPA FVG's vision.

Therefore, the questions which remain open for ARPA FVG are: 1) whether its mission ("what") and vision ("why") are complete as they are formulated today or whether they should include a more systemic IC perspective; and 2) whether a regional agency such as ARPA FVG should engage more actively ("how") its internal and external stakeholders ("who") to contribute to co-creating public value.

The strategic plan for 2019-2021 does not focus on these issues. It foresees investments in three areas: infrastructure and equipment in order to further centralise, rationalise and improve ARPA FVG's operations; bringing together all regional protection functions which are now spread across ARPA FVG, the Regional Civil Protection Unit, the Regional Environment Directorate and the Regional Health System; intensifying the cooperation between the Regional Environment and Health Observatory and the local and regional healthcare agencies in order to better assign the responsibility and accountability for the health effects of environmental conditions. There is no explicit mention or even a reference in the plan to IC management or collective intelligence, apart from the importance to coordinate knowledge and experiences through 4.0 technologies and to keep disseminating and promoting ARPA FVG's activities across its stakeholders as well as the Region's businesses and population at large.

6. Final remarks and implications

This study contributes to reinforce and further develop trends in IC research and quests for the development of new management models for the public sector.

On the one hand, the research validates the existence of ecosystem frameworks in public administration and the key role played by IC in their design, creation and implementation. Further in-depth insights was developed by considering also the three basic components of human, structural and relational capital, that is rational capital, emotional capital and spiritual capital (Bratianu, 2018). Moreover, the appreciation by senior public managers for the increasing importance of managing also external stakeholders further testifies to the recent shift towards holistic approaches at the basis of the fourth stage of IC research.

On the other hand, findings highlight the need for a broader rethinking process with a defined role for IC management, stakeholder engagement and collective intelligence in governance models for the public sector. As value is created and embedded in relationships and exchanges across multiple actors at different levels and stages of the public service delivery process, managers need to manage IC while engaging multiple stakeholders in order to foster collective intelligence so as create public value. Hence they need to understand the impact of different and competing stakeholder logics (Bryson et al., 2017; Best, Moffett and McAdam, 2019), that is how stakeholders create opportunities or challenges for value co-creation at different stages and levels of a service ecosystem. This allows practitioners and public managers to target approaches and resources that align stakeholder interests and help maximize value creation (Best, Moffett and McAdam, 2019). The development of such a public service ecosystem logic allows a more holistic, dynamic and sustainable perspective to value co-creation with an emphasis on public institutions as coordinators and catalysts (Vargo and Lusch, 2016; Matos et al., 2018; Osborne, 2018).

Moreover, practitioners as well as the academic community should acknowledge that research concerning IC and value co-creation is beginning to adopt an innovative perspective by investigating social media that include data which has not been necessarily formally disclosed and reports that analyse non-strictly financial information (Dumay and Guthrie, 2017; Massaro, Dumay and Bagnoli, 2017; Ndou et al., 2018; Secundo et al., 2018). This has at least three implications for public organisations. First, an inclusive IC culture that fosters transparent and comprehensive disclosures with stakeholders through traditional and new channels should be promoted in order to help engage stakeholders. Second, new approaches, strategies and infrastructures need to be developed to acquire, store and manage the data continuously created in an ecosystem, so that Big Data can be a relevant contributor to foster value co-creation. Third, managers would need further training and resources to appreciate the type, amount and timing of IC being already disclosed and of IC that could be disclosed.

This contribution is not without limitations. First, there was no opportunity to include the views of ARPA FVG's external stakeholders and service users. We have focused only on one-way communication, i.e. the disclosure of information by a public agency for its stakeholders. We did analyse social media, but to no avail in this respect, because of the non-interactive use made by ARPA FVG of these tools. Moreover, this study has the usual limitations of a single case study. The restricted field and geographical area of the research grant for the

prospective application of its findings to other contexts. We suggest that our insights may be applicable to examinations in future comparative case studies with evidence from public organisations in other sectors and geographies in order to shed further light on IC management, stakeholder engagement, collective intelligence and value co-creation.

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