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Performative approach towards a sustainable environment; the Viplan Methodology

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Abstract

An Enterprise Complexity Model (ECM) is offered as a methodological tool to achieve the distributed governance of an ecology of evolving enterprises towards sustainable goals. Governance is understood as guiding an enterprise's self-organization towards policies creating, regulating and producing sustainable development goals (SDG). Self-organisation is grounded in correcting imbalanced interactions of stakeholders, to increase their requisite variety to achieve sustainability. An ECM guides, with the support of current and disruptive technologies, the interactions of an enterprise with agents in its environment. An enabling context helps the branching of an enterprise's creativity into all kinds of innovations, forms of coordination and operational alignments with environmental agents. Respect for the environment, fairness and social justice are values driving this ecology of enterprises towards a deeper and wider appreciation of the issues besetting future generations.

Introduction

This paper is an evolution of some of my earlier writing, in particular a paper published in IJSS, Vol 2No1 pp.1-22 (Espejo, 2015a) and a chapter in Stowell´s book "Systems Research for Real World Challenges" (Stowell, 2018) and is an evolution of some of my more recent publications (Espejo and Foss, 2018), (Espejo, 2018) and recent talks and lectures. This new version offers a significant development of the Viplan Methodology (Espejo, 1993) and clarifies its relevance to the governance of responsible enterprises.

The focus of this paper is responding to the methodological challenge for an enterprise wanting to learn how to develop an ecology of enterprises towards sustainable goals. An Enterprise Complexity Model (ECM) is an extension of my earlier work about the Viplan Methodology (Espejo, 1993) and the Viplan Method (Espejo, 1989b), and is grounded in Beer's Viable System Model (Beer, 1979, 1981, 1985). In general, an ECM is understood as an innovative undertaking in society that goes beyond individual enterprises; it offers a model for the alignment of collaborative enterprises rather than a model of any particular enterprise

or institution. It is a model of an ecology of enterprises, often guided by a leading one, dealing with the complexity of multiple natural and social environmental agents. It is in the nature of this enterprise to operate in a context of challenges and opportunities for the long term, which requires of ingenuity and capabilities to enhance its significantly smaller complexity. The challenge for the enterprise is to find ingenious strategies to bridge this complexity gap[1]. Today's economy and the digital technology can play an increasingly important role in making this bridging more effective and socially acceptable. This paper offers responses to these challenges from the perspective of systems thinking and cybernetics. How is it possible for an enterprise to perform effectively under increasing social, ecological and economic demands? How does it achieve viability in these challenging circumstances? These are questions for which Beer's Viable System Model (Beer, 1979, 1981, 1985) gives powerful answers. The particular methodological extension offered by this paper is an ECM to respond to what the enterprise may construct as an unsustainable environment. The digital society shares with the Viable System Model (VSM) its focus on complexity as it is understood in this paper, that is, of the huge number of possible states, or variety, of any situation (Ashby, 1964)[2]. The digital society, as we are witnessing it today, is grounding social activities in technologies with large capacity to create as well as to map all kinds of situational states. Today enterprises of all kinds can balance people's relational variety from the most disaggregated levels to the global level. Algorithms, artificial intelligence, 3D printing, engineering services and so forth are making possible for an enterprise to correct variety imbalance in real time. Rather than dealing with aggregations and averages, this enterprise can offer individual services, through structures and algorithmic models, to its customers. In other words its services can be tailored to specific and individual needs. People's distributed responses to environmental challenges can be managed not only at aggregated levels but most significantly at local levels by local providers through enabling technologies, adding flexibility and convenience (Espejo and Foss, 2018). Through computer networks an enterprise can increase its performance through inclusion of other enterprises and agents in a network of autonomous units, rather than remaining as an independent unit.

The VSM provides a powerful heuristic for balancing the huge number of possible states constituting an enterprise's complexity to the even larger number of possible states of its environment. *As is discussed later the accounting for this balancing can help to develop its capabilities to respond effectively to challenging environments.* The Enterprise Complexity Model (ECM), as offered in this paper, is a methodological extension of this model focused on problem solving rather than on the viability of an enterprise. It is a guiding model of the enterprise's need to manage the ever increasing complexity of an environment through collaboration and coordination with others, rather than by attempting to go alone as a single formal enterprise. Examples of this management are offered in this paper.

The opportunities and threats that enterprises are experiencing in their surroundings suggest that they need to invent and develop ingenious organisational forms, often beyond their formal boundaries, to match these challenges. The ECM offers a methodology for the on-going re-invention of an enterprise's organisational form to bridge environmental demands. This is an application of the *Viplan Methodology.* ECMs are helpful to visualise and develop

[1] This is my interpretation of Thomas Homer-Dixon's Ingenuity Gap (Homer-Dixon 2001).

[2] Ross Ashby proposed variety, or the number of possible states of a situation, as a measure of the complexity of that situation (Ashby, 1964).

an enterprise's dynamic capabilities[3], and it offers a heuristic to create, maintain and develop innovative organisational forms through people and technology.

Similarly to the VSM, which is concerned with making viable desirable purposes, the ECM offers a systemic model to map an enterprise's resources and relationships with others, to strive for, and maintain in collaboration with other enterprises and resources, the sustainability of an environment threaten by society's reckless activities and by nature's challenges. The VSM postulates an *enterprise* as an independent unit, and the ECM, postulates a collective of enterprises as an *organisational system* constituting the VSM's five systemic functions; policy, intelligence, cohesion, coordination and implementation (Espejo 2003). All the resources producing either the enterprise or the ECM have one or more of these systemic functions, or in other words, all resources can be mapped onto one or more of these systemic functions. *Together the five interrelated systemic functions may constitute an organisational system* (Espejo and Reyes, 2011). An enterprise achieving viability on its own, as well as distributed resources and enterprises, complying with the requirements for viability, are postulated as organisational systems.

The Viplan Methodology uses the *Viplan Method* to *diagnose* and *design* an enterprise's structure. In its diagnostic mode, Viplan, as a method can be used to assess whether an enterprise is adequate or not for its ascribed, or de facto, purposes. Through diagnosis it is possible to work out archetypical organisational shortcomings (Espejo, 2008) that offer guidance for improvements. In its design mode, from the ascribed purposes, Viplan works out the configuration of resources and relationships that are necessary to produce an effective structure. The Viplan Methodology uses this latter mode to model the dynamic adaptation of resources to a changing environment; this constellation may be proposed as an ECM.

In what follows, first, I discuss enterprises, institutions and organisational systems. They provide the shared systemic foundation for Enterprise Complexity Models. Second, I explore complexity and requisite variety (Ashby 1964) as key constructs to study and develop ECMs. Then, thirdly, the Viplan Methodology is proposed as a methodology supported by two learning loops, the cybernetics loop underpinned by Beer's Viable System Model and the problem solving loop underpinned by Checkland 1981 and Espejo, 1993). I finish with a reflection about the contribution of the ECM to our understanding of an enterprise's performance in a network, with a focus on environmental sustainability and governance.

Enterprise, Institutions and Organisational Systems

In the network economy the formal enterprise usually is different to an organisational system. This is an important distinction. In the network economy, more and more, enterprises *name* what they do as transformations of inputs into products that go beyond their own capabilities. To produce these transformations they require the contribution of other enterprises; they are naming an *organisational system* that is different to the enterprise in focus. Making viable this organisational system is a means of working out the viability of an extended set of enterprises. Methodologically, *a focus on an enterprise alone is too restrictive. The extended set of enterprises is now the system-in-focus to which the VSM is applied.* The individual enterprise's viability is likely to require more than producing individual products or services, but furthermore success *producing* a network of resources and enterprises. The participants

[3] Eisenhardt and Martin (2000) define dynamic capabilities as 'the firm's processes that use resources – specifically the processes to integrate, reconfigure, gain and release resources – to match and even create market change'

in this network of the ECM of course can and do change over time. Examples of ECM are offered in what follows.

Public Sector Institutions

In the public sector these networks often go beyond a particular *institution*. These institutions often do not create, regulate and produce their services by themselves. For instance in education, the ministry responsible for a country's education is unlikely to deliver educational services by itself. The ministry, as an institution, depends on the collaboration of thousands of schools and millions of families to deliver the country's necessary educational services. Unless it succeeds in creating this larger organisational system, the ministry will fail in delivering the country's educational policy (Espejo, Bula, & Zarama, 2001), (Espejo and Reyes, 2011). The system in focus is the educational system and this is the "extended enterprise" that needs of an evolving ECM for the design and development of an educational systems beyond the ministry alone. The ministry is a *public institution* for which the total educational system is the *organisational system*[4]. The institution alone, in this case, is not an organisational system. Of course a study may focus its attention on the institution, but it will need to recognise that the institution's performance is highly dependent on the quality of its relations with the other contributors to the organisational system. Otherwise the study may reinforce the customary fragmentation of public services. Of course if individual *public institutions* create, regulate and produce their services, such as could be the case of autonomous public and private schools, they are enterprises and also organisational systems. In recent times it is common to find public-private partnerships (PPP). This type of arrangement is a form of delivering services to society. These public institutions are leaders of *service delivery networks* in collaboration with the private sector. The focus of the Viplan Methodology is on the viability of these PPP networks rather than on the public institutions alone. Thus, the system-in-focus is larger than the public enterprise and its constitution can be more flexible and susceptible to on-going changes. Instilling flexibility in enterprises and institutions is a dynamic process that may require considering an enterprise complexity model with boundaries beyond the public institution (West et. al, 2014).

Lead Enterprise

Globalisation is being exploited by many enterprises through the creation of networks. For instance a company's purpose may be producing computers; however at a closer scrutiny it becomes apparent that it is a *lead enterprise* to produce computers, in a network with many other enterprises and resources. In this case the system in focus is the organisational system that creates, regulates and produces the computers, which is a network of enterprises that creates, regulates and produces the products agreed by the network with the lead enterprise. While each of the networked enterprises may well be an organisational system in its own right, the lead enterprise requires effective communications with its network of enterprises to achieve viability. This kind of structure requires a quick reconfiguration of resources. The core competencies of the lead enterprise support the clustering of a wide range of enterprises; these enterprises can vary according to environmental demands and local circumstances. This flexibility allows the lead enterprise to develop its own dynamic capabilities in collaboration with the network.

A core competency for enterprises today is managing relationships and interactions that are continuously changing as new technologies and environmental conditions make possible

[4] Public institution, in this context, is a formal body in a society created by law to deliver a public service (Espejo & Reyes 2011).

changing configuration of resources and therefore asserting different strategies to manage their own and environmental complexities. This is a process of creating new structures based on the existing ones. In this sense Viplan is about supporting significant structural adjustments, even changing identities, as new conditions emerge.

Another instance of a lead enterprise is that of science parks, which have been set up near universities around the world for decades. Science parks provide common services to enable the viability of high technology enterprises. However, in this case, each enterprise maintains its own concern and identity. In this case the consonance ((Barile, Saviano, Iandolo, & Calabrese4, 2014) of the involved enterprises may be weak, but, as a network, they share the enabling communications of a lead enterprise. The transformation of the Science Park, as an enterprise, goes beyond the economies of scale of providing services to enterprises sharing a physical space but it extends to communications for innovation. Thus the transformation of the lead enterprise is *orthogonal* to those of the peer enterprises under its umbrella. Making the Science Park, as an umbrella enterprise, viable does not imply that it is producing sophisticated software applications or transducers for industrial applications or many similar possibilities. These are the concerns of its embedded enterprises. It implies enabling *communications* for innovation to a network of enterprises. In the longer run the viability of a science park will depend on successful and synergistic tenants forming a collective organisation; some form of collaborative complexity management should take place.

In all cases, even if its transformation is not aligned with the transformations of some or all of the networked enterprises, the lead enterprise should strive for its own viability, as it develops orthogonal communications with the network. This lead enterprise could provide to the enterprises using its services not only technological infrastructure, meeting facilities, printing facilities and several other regulatory capabilities, but also collective innovative capabilities to make possible a viable collective enterprise.

Peer Enterprises

A more general alternative organisational form is that of enterprises aligning their interests to constitute bottom up a larger enterprise. Each has an independent transformation of its own, but they may agree to produce together a larger, encompassing, transformation. For the Viplan Methodology the system in focus is the larger, self-organising, organisational system emerging from the *member* enterprises. Provided they achieve cohesion they are forming a larger organisational system. This is the case, for instance, of a cluster of aligned regional enterprises. Regional policies may enable producing a collaborative cluster. What is particular to this case is the alignment of their interests. One enterprise may operate as a catalyst -as primus inter pares- but it has its own transformation; all enterprises depend on external resources supporting the cluster and steered by regional or sectorial policies and management bodies. This idea can be extended to develop virtual relationships with similar and complementary enterprises in different regions and with larger complementary enterprises of a global nature, forming what O'Callaghan has called an extended dynamic clustering (Nachira et al 2007). What is of particular relevance today is that these forms of collaboration are supported not only by shared cultures (Foss and Espejo, 2018) but by ICTs that few years back where unavailable (Avril & Zumello, 2013, Johnson, S., 2012, Christensen, C. et al, 2009, Tapscott, D., 2009, Teece, J.D., 2008, Harari, 2017, 2018, Schwab, B, 2017, Zuboff, 2019). Standards for collaboration are evolving constantly, making possible routine exchanges and communications between enterprises as if they were parts of the same enterprise.

In summary, methodologically, Viplan makes the distinction between enterprises, institutions and organisational systems. An organisational system can be much larger, but also smaller,

than either an enterprise or an institution. It is the organisational system in focus that is considered the response to the opportunities and challenges posed by a relevant problematic environment. Naturally, if an enterprise or institution creates, regulates and produces its own products/services, and is the focus of the study, then it can be the system in focus, whose structure and identity are studied with the support of the VSM. However, if the focus is one institution that does not create, regulate and produce its products/services but only does one or two aspects of this triplet, then the organisational system will be larger or smaller than the institution, as was the instance of the educational system explained above (Reyes, 2007).

Sustainability, Complexity and Requisite Variety

Sustainable development goals as proposed by the United Nations Development Programme (2018), are to different degrees, huge challenges for enterprises. In the language of complexity this means that natural and social agents in the environment are generating much additional variety for which most likely individual enterprises may have no response capacity today. In an environment suffering sustainability issues, it is natural for enterprises to experience huge problematic situations. In these circumstances they either create responses or risk underperforming to the detriment of a sustainable environment. In other words, in a dynamic and challenging world, the number of possible relevant states that they should deal with is increasing all the time, possibly beyond their immediate performative capabilities, and unless they develop commensurate response capacity they will underperform (Ashby, 1964).

In fact, the variety, even of simple situations, is exceedingly large (Beer, 1979). More so, for governments, paying attention to global environmental situations such as society's health, and their implications to millions of individuals' health. To avoid being swamped by variety, participant observers, ascribe purposes to social issues. This would suggest that they need to observe their interactions holistically rather than in a piecemeal fashion. Unfortunately this is not always the case. In a cognitive sense they often define their situations as fragmented black boxes, with many independent inputs and outputs, failing to recognise the advantages of absorbing complexity through taking advantage of local situational connectivity. This is failing to decentralise the management of a situation and remaining in a hierarchical arrangement. Overcoming this shortcoming is a purpose of the ECM.

Dealing with threats such as global warming or dealing in general with sustainable development goals, require far more than trial and error; situations are too complex and time is too short. We need ingenuity, inventiveness, creativity and resources to produce desirable outcomes and avoid poor complexity management. For an enterprise these are all problem solving situations that share a common structure; the need for intelligent forms to attenuate (reduce) its situational complexity and to amplify its response complexity. Performance depends on the ongoing balance achieved between attenuation and amplification; these interactions define performative eigen processes ((Espejo & Dominici, 2016; Pickering, 2010), (Lassl, 2020)) within the enterprise and between them and their environments, driving learning processes towards enterprise complexity models (ECM).

ECMs aim at correcting variety imbalances in an enterprise's performance, that is, ECMs deal with performative situations relevant to their interactions within the environment (Pickering 2010, Espejo and Foss, 2018). Operating in this context poses challenges –it is a learning experience- making apparent that one way or the other enterprises –as long as they remain in operation-to perform well- they need to match situational varieties. Enterprises are constantly striving to regulate a challenging surrounding. To perform well, through interactions, they need requisite variety operators, that is, particular strategies and practices to deal with the variety of their environment through self-organisation and self-regulation (cf.

Espejo and Reyes, 2011) to make their *residual variety* manageable (Espejo, 1989a). What is of significance is that for any situation unwittingly a wide range of variety operators co-evolve, thus constituting the communications between the enterprise and its situational environment. The quality of these operators defines the enterprise's performance or alternatively achieving a desirable performance requires requisite variety operators. Unfortunately, more often than not variety management is inadequate to achieve sustainable development goals. *An imbalance between amplifiers and attenuators in the interactions between an enterprise and its environmental implies a waste of resources and poor performance. This may be happening precisely in situations where the enterprise should strive for more and more ingenious forms to solve a problem.* Thus, from the perspective of complexity, the question is how to develop more ingenious and effective forms of variety management. Indeed, not only these forms are influenced by available technologies, but also, in challenging new situations, by the search of new technologies and scientific discoveries. *ECMs are proposed as forms of variety management for specific problematic situations.*

For any enterprise, new developments beyond its capabilities, such as a pandemic (e.g. COVID-19) organisational improvements supported by new scientific discoveries or technological breakthroughs are necessary. If the ECM is proving ineffective and its regulatory cycle with the environment - its attenuators and amplifiers in use- is inadequate, new developments are necessary to redress the balance of these variety operators. Indeed, often these new scientific and technological developments affect this balance, requiring stronger more focused attenuators and amplifiers. Not surprisingly new global communication demands are challenging the response capacity of enterprises everywhere. Proliferation of variety that is not accompanied by appropriate variety management *within* the environment and *within* the enterprise itself, and between them, traps enterprises in non-learning situations; they fail to understand the consequences of the evolving new states. They risk reduced performance, and in the case of a pandemic, to unnecessary deaths. Enterprises need a holistic appreciation of the situation. This holism is at the core of the enterprise's complexity model. This view implies that to learn and improve performance, enterprises have to improve in tandem their capabilities to observe and articulate environmental distinctions and to diagnose and design responses.

A consequence of new technologies is increased connectivity –at all structural levels, from the local to the global- that possibly enterprises have not experienced before, as they operate less and less in isolated niches and appreciate more and more the consequences of their actions beyond their local environments. It would appear that the new technologies are increasing people's holistic (i.e. systemic) appreciation of their organisational world. In this sense technologies are changing the nature that enterprises are confronting in their quests for sustainability. Learning loops are essential to maintain a dynamic stability and reconfigure the enterprise's dynamic capabilities. The invention and deployment of new technologies play a key role in this evolution. Enterprise Complexity Models offer a conversational platform to use new technologies in the constitution of sustainable environments.

To sum up, enterprises are constantly confronted with challenges that exceed their response capacity. To maintain viability they require ingenuity, inventiveness and resilience. ECMs offer opportunities for an enterprise to confront sustainable development goals in a complex world. This view emphasises the co-evolution of an enterprise in its self-constructed environment and the entrepreneurial efforts that are necessary when this enterprise is confronted to challenging problems of related sustainability.

The Viplan Methodology: strategies for a sustainable development

Unfortunately, enterprises are often structurally fragmented and their interactions are dysfunctional to the requirements for sustainability of, for instance, a healthy society. They are often focused on short term results and are insensitive to the consequences of their longer run performance. The aim of the Viplan Methodology is increasing an enterprise's consonance with its environment (Barile, et al. 2014), to contribute to its own and the wider environmental sustainability. How can an enterprise increase its sensibility to the world around? The challenge is, for a given purpose, to improve its cybernetics; how to increase the quality of its structure, from the most basic to the most global interactions and resources. Organisations are structure determined (Maturana, 2002). How to make its people operate in a free and creative environment that gets the best out of them? All this is necessary to recognise problems and to create opportunities for implementation and for innovation. The idea is improving people's interactions as well as improving the organisation structure to get the best out of them. All these are requirements for effective performance and positive contribution to environmental sustainability. In the context of the Viplan Methodology the Viable System Model (Figure 1), is a model for these purposes:

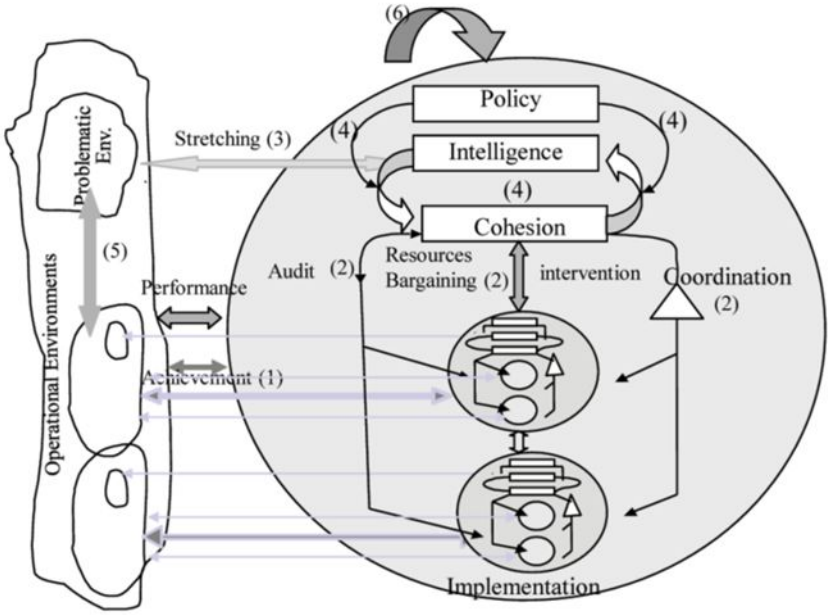


Fig 1. Viable System Model: Reference Model (Reference Beer, 1979, Espejo 2008)

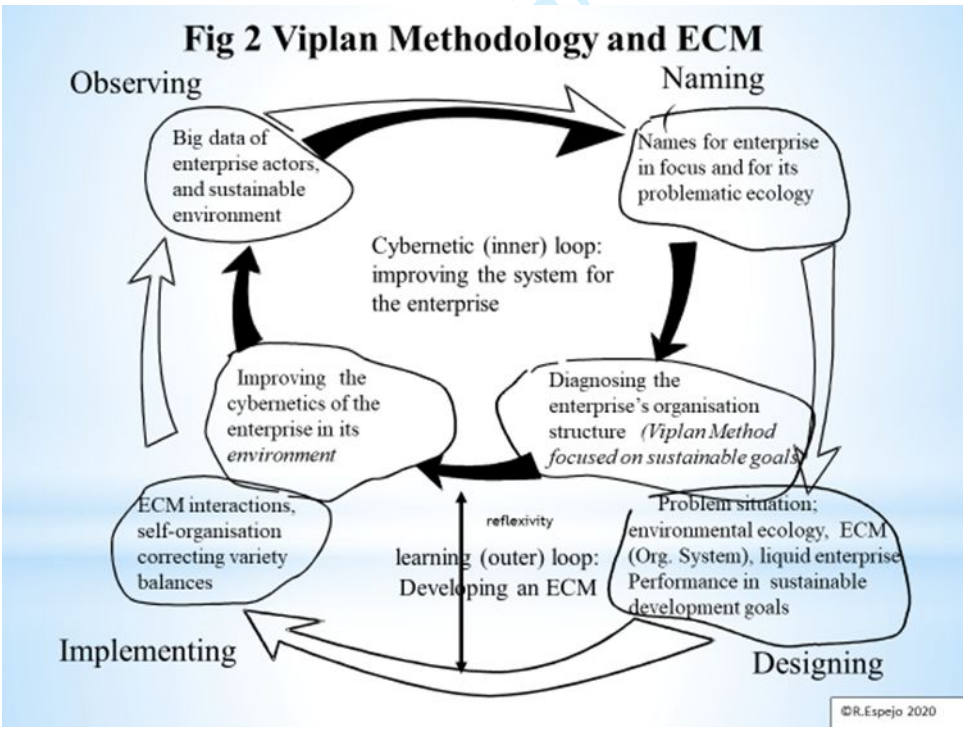
And the Viplan Method (Espejo, 1989 b) is a tool to diagnose those aspects that are limiting the enterprise's performance (Espejo and Reyes, 2011). This diagnosis highlights the need to correct stakeholders' interactions which are out of balance. In particular their shortcomings in their conversations for policy implementation, innovation and sustainability.

Enterprises today are evolving in environments that are significantly different to those of the 20th century industrial economy. The 4th Industrial Revolution is overloading enterprises with big data, is offering artificial intelligence models, blockchains, internet of things, and

many more enabling technologies (Schwab, 2017). New enterprises are driven by these collaborative technologies that allow them to correct shortcomings in their interactions, increasing opportunities for self-organisation and getting the best out of limited resources. These technologies facilitate, if successfully implemented, less hierarchical networks and new organisational forms that are more participative and inclusive.

The Viplan Methodology is intended to manage the complexity of problematic situations (Espejo 1993), which in this paper is sustainability (see Figure 2). It provides a learning platform that bootstraps an enterprise's dynamic capabilities to its value chain in the environment. The inner (diagnostic) loop of Figure 2 highlights an enterprise's learning starting from its current structure, which among other aspects, aims at increasing environmental sustainability and performance. This structure, if adequate, should offer a distributed and balanced capacity to manage the enterprise's tasks and therefore it should offer the best opportunities to bootstrap new capabilities to respond to the enterprise's evolving purposes and values in a changing environment. This is the purpose of the second outer (development) loop. This loop gives the chance to people in the enterprise to construct an ECM as a model of the necessary structures to develop the enterprise's ecology of enterprises to interact with environmental agents. These structures are necessary to create and implement sustainable strategies and offer reflexive interactions that help re-entering them in both directions, making apparent that they are true communications between the enterprise in focus and enterprises in its environment, rather than unilateral one way information transfers. For the Viplan Methodology *reflexivity* is a mechanism to correct and balance the varieties between the inner and outer loops, as is illustrated in Figure 2 (cf. Espejo and Foss, 2018)

Fig 2 Viplan Methodology and ECM



The inner loop is about improving the structure of the organisation in focus, such as an energy supplier or a local hospital. At the same time this loop may develop reflexivity with those enterprises and resources that are contributing to handle goals for sustainable development, constituting the ECM in the outer loop. Reflexivity improves the collective structure of the enterprises emerging in the outer loop from their interactions with the

enterprise in focus in the inner loop, while at the same time these interactions are changing and improving its own structure. The purpose of the enterprise in focus may remain unchanged, but its structure is likely to be fluid as it constitutes an ECM. These fluidity is reflected in Figure 3, which is no more than Figure 1, but now with dotted circles, showing that the boundaries of the enterprise, at all recursion levels, are fluid.

Reflexivity of Inner and Outer Loops; from diagnosing and improving the cybernetics of an enterprise to constructing an "enterprise complexity model" for problem solving

The starting point for an ECMs is the concern for an enterprise to interact with multiple agents towards a sustainable environment. The enterprise needs to work out a desirable transformation to bridge its complexity gap with a challenging environment. From a complexity perspective, working out this transformation is a key aspect for policy making. It helps clarifying the systemic purposes of the enterprise's resources. It can be a health service of a city, a hospital, a school, or any other enterprise. This clarification is a methodological challenge. A clear transformation opens up conversations about resources, environmental challenges and extending or modifying the enterprise's boundaries (see Figure 3).

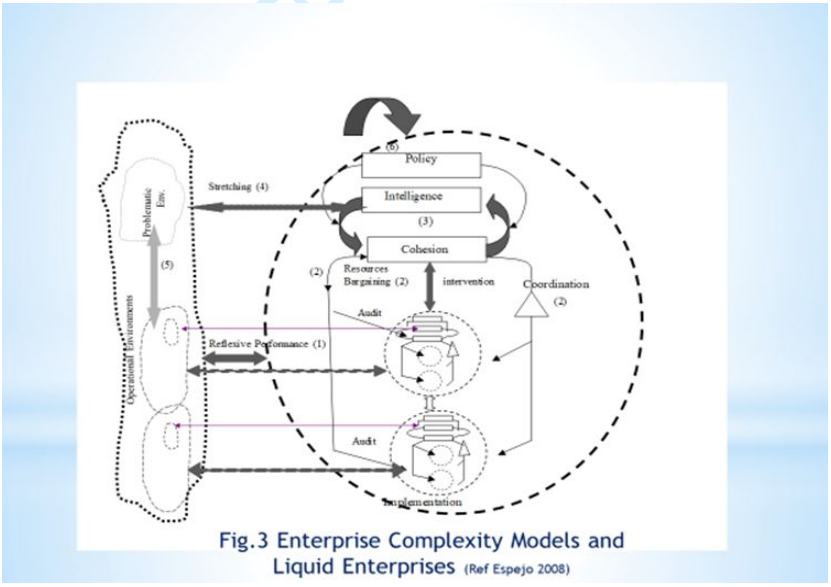


Fig.3 Enterprise Complexity Models and Liquid Enterprises (Ref Espejo 2008)

In the cybernetic (inner) loop of the methodology (Figure 2) observers name the transformation that in their view the enterprise is producing in its environment; additionally they name inputs, outputs and stakeholders. The VSM (Figure 1) is the *heuristic* to produce and manage the complexity of this transformation. For a particular transformation -for instance, an energy enterprise- it is very different if observers see the enterprise as producing and distributing electricity, starting from non-renewable fuels, going through energy producing plants and finishing with networks distributing energy in the market, than seeing it as an enterprise that only distributes energy. The VSM with the Viplan Method, underpin the methodology. The method pins down the chunks (sub-transformations) of complexity that the enterprise is *managing* as self-contained units. Within themselves these chunks should be strongly interconnected operationally, but, we expect that between them they should have less operational interdependence. This chunking is a means to reduce the *residual variety* (Espejo, 1989a) that is relevant to the enterprise's management; most of the variety is self-contained

within the chunks, under their own management. Together these chunks produce the enterprise's transformation. In a diagnostic mode, observers see chunks of a transformation and their regulation. They see the enterprise's selected strategy to contain the variety of its self-defined transformation, which in our energy example is to produce energy. For each chunk the enterprise develops an organisational unit to match relevant environmental complexity and together they matches, if successful, the complexity of producing energy. We can assume that through a learning process the enterprise reaches a strategy to match the variety of producing a clean energy with autonomous chunks of organisational complexity, implying that these chunks, as set up in the enterprise are an empirical measure of its relevant environmental complexity. The situation is different when the purpose is more than the diagnosis of an energy enterprise but the design of an *organisational system* for an affordable and clean energy, say, for a region. This in fact may well be the problem situation, where an ECM can help. In this case we start from an enterprise's current transformation as a reference; and we propose a new chunking for a clean and affordable energy. This may require an innovation or a new business model. For this transformation it is necessary to create a new complexity management strategy, or an Enterprise Complexity Model, which may require partnerships and agreements with other enterprises, whether these are suppliers, customers or stakeholders in general. The challenge is designing a network of collaborative enterprises, which may make use of the advantage of distributing the management of environmental complexity among various complexity drivers; this distribution can be referred as innovative technological and structural models. It is only when the enterprise embodies *together with other enterprises and resources the requisite organisational units to produce the transformation* that it is operating with an *enterprise complexity model*. In the Viplan Method those self-contained organisational units producing the enterprise's transformation at different structural levels, define its *primary activities*[5] and its *unfolding of complexity* (Espejo, 2003). This is the enterprise's strategy to manage the complexity producing its wider transformation. Each of these chunks needs autonomy to produce something cohesive in a complex environment. A one to one matching between the chunks identified by structural and technological models and primary activities will be the outcome of debates as the enterprise clarifies a possible *enterprise complexity model*.

The inner loop of the Viplan Methodology is about making an enterprise's structure effective, that is, making good its cybernetics . This structure is necessary to increase its capacity to create better conversations and interactions to produce innovative products and services from the local to the global[6]. Resources may be centralised or decentralised according to the enterprise's strategy to deploy resources and the available *technologies*. For instance, particular technologies may permit more centralisation without bureaucratisation (Espejo, 2008). Other technologies may allow more decentralisation without losing cohesion. As new technologies emerge, different configurations of resources with external resources are possible. Indeed, the distribution of complexity may change not only within the enterprise, but perhaps, more of the enterprise's transformation, and related chunks, can benefit from the support of external agents, allowing an enterprise's slimmer and perhaps more effective structure. Anticipating and discussing these changes is a purpose of the ECMs.

The inner loop creates the conversational and structural platform to develop an enterprise's dynamic capabilities to improve its performance towards the development of a sustainable enterprise. The Viplan Method helps to diagnose the enterprise's organisational identity and

[5] Primary activities of the ECM are those directly producing the extended enterprise's transformation.
[6] Including all its full complexity and not only the intelligence capabilities of the global level.

structure (Espejo, 2008) and supports its final activity; improving the existing context for distributed development and innovation in the enterprise. This is a platform to bootstrap the learning (outer) loop of the methodology in the *reflexive process* of developing the ECM.

An ECM, in this situation, is a model of the strategy of an ecology of enterprises to manage the complexity of an enterprise's interactions with agents in its environment. It should be an ingenious form of relating resources to bridge the complexity gap between the enterprise and agents in its environment in the quest for an enhanced sustainability.

This complexity management entails the creation, regulation and implementation of an extended enterprise policy. The key aspect to appreciate is that the ECM is a methodology focused on problem solving rather than on the viability of a particular enterprise; this is the purpose of the inner loop. In the outer loop the VSM is a model to visualise the complexity of a self-organised system, taking place in a highly complex environment. The ECM's key concern is working out its boundaries, finding ways of understanding and operationally measuring the complexity of its chunks, reconfiguring its resources taking into account technological developments and the complexity of the environment and supporting the emergence of a cohesive and adaptive structure. In order to reconfigure resources it is necessary to understand their systemic contributions to the extended model of the enterprise, that is, to its ECM. Are they supporting aspects of its policy, intelligence, cohesion, coordination and implementation functions, at different recursive levels?

What is the problem solving space for the enterprise? The question is the mismatch between its current structure and its environmental challenges. This step starts by clarifying the enterprise's new transformation. The transformation (in the outer loop) is bootstrapped to the ongoing diagnosis of the enterprise's cybernetics in Figure 2 in the inner loop. This diagnosis is done with the Viplan Method. Can resources be better deployed, and can relationships be more effective and interactions corrected to enhance variety management? However, as the diagnosis is done, it is natural to discover changing environmental conditions and whether or not a new ECM is necessary. The enterprise is learning from its environment, which may require adaptation to produce more effective responses. This is a matter of ingenuity; the enterprise may need new organisational forms to bridge the variety gap with its self-defined surroundings (Espejo, 2017).

Reconsidering what is going on, naming a new transformation, or finding better ways to do what the current one is doing, is at the core of extending the viability of an enterprise. This is a trigger to develop an ECM with the support of the outer loop. In the network economy new forms of transforming inputs into outputs are emerging constantly. Information and communication technologies (ICTs) as well as new models (e.g. system dynamic models, mathematical models and others) are making possible networks and alternative forms of association for enterprises. Producing an enterprise's services can take place in different parts of the world and with different technologies. Discussing the enterprise's boundary is essential to reinvent the strategy to carry out its revised purposes. More and more these boundaries entail several, if not many, other enterprises. The organisational system that it implies -the new system in focus- is likely to be larger than the current enterprise; the ECM needs to consider resources and relationships beyond the existing enterprise. The named new transformation implies tasks that are performed by other enterprises. This fact implies developing relationships of cohesion for this new network of enterprises, which requires coordination and integration systems to overcome, among other aspects, distance and time differences to facilitate sharing resources among the network. Standardisation of services and procedures between the different enterprises becomes essential; enterprises data interchange, communication protocols (e.g. blockchains and operational coordination) for B2B

interactions help giving cohesion to the ECM. Software, improved models and many other coordination technologies are necessary to build up trustful relationships. These technologies are enabling increasingly reliable communications throughout the organisational system. These developments are making possible new and more flexible liquid organisational forms (Bauman, 2000) (cf. Figure 3).

Defining the problem solving space helps appreciating the complexity gap between the enterprise and its self-defined environment. This is the role of the new ECM. In this case, an aspect of problem solving and therefore of the ECM, is visualising a new network of enterprises -a new business model- to produce the new problem solving system (outer loop in Figure 2).

The outer learning loop of the Viplan Methodology is bootstrapped to the current enterprise's technological and structural models, that is, a new ECM, with a new problem solving space, is bootstrapped to the current one. This is proposed as a heuristic to assess the organisation's strategy to manage complexity. Methodologically, Viplan requires that technological and structural models are produced to visualise a new cluster of networked enterprises producing the organisational system.

Producing an enterprise's new products and services transform an ECM's inputs into services for, in our case, desirable sustainable development goals. As already said, producing this new complex transformation entails different interrelated chunks of complexity or tasks, which can be deployed in different forms. This new technological model is a preliminary map of how to produce these services. In practice these maps co-evolve from the interactions between chunks of complexity, emerging from the technologies at hand, and agents producing environmental pressures.

Breaking a transformation into manageable, self-contained tasks, is an important strategy to manage its complexity (Simon, 1981, Beer, 1979). A small consultancy task may be within the scope of one person. However, manufacturing an autonomous (self-driving) car, requires many, largely self-contained, tasks (i.e. chunks of complexity). These tasks need to be properly coordinated and integrated through an effective organisational structure; thus decisions about this chunking are of key importance for an effective organisation. If the chunking leaves out aspects of what we may consider are highly interdependent activities, then the organisational system will be forced to align their interdependencies. It will be necessary more coordination of these aspects by external supervision reducing the benefits of having largely autonomous chunks. In any enterprise we may expect teams absorbing from within as much as possible the complexity of its autonomous chunks; they attempt to absorb as far as possible the contingencies that may take them off course. A workflow composed of multiple chunks that define the enterprise's technology may require clustering them within larger more aggregated chunks that define the enterprise's strategy to manage its complexity. This chunking is the outcome of the enterprise's experience managing the complexity of a transformation and as such it could be the source of learning practices. In the case of successful enterprises these models may well be good practices that are used to learn and improve performance. Good practices from other enterprises support the development of the core enterprise. It is natural to expect that multiple practices or technologies may emerge to produce the same transformation suggesting the possibility of multiple technological models and their related unfoldings of complexity.

In the language of the Viplan Methodology, and with reference to sustainability, there are alternative forms to manage the complexity of a sustainable development goal; these are learning strategies. Perhaps, the simplest way to start this learning process is to model the

current way in which the enterprise is producing its services (as modelled in the inner loop) and *reflexively* learning from the outer loop. Searching for new practices would be a form of increasing the enterprise's learning. Overcoming constraints to this learning is in fact a purpose of the outer loop. This search for a new technological model, in line with new technologies and logical models, is at the core of ECMs.

Furthermore, the complexity of an enterprise is more than managing the interrelated chunks producing its services. Were that the case the enterprise would be limiting its value adding to managing its production processes with no concern for evolving environmental challenges. This would mean restricting learning without *reflecting* what is happening in the outer loop. In fact the complexity of an enterprise extends beyond producing particular services or products; new environmental challenges are increasingly more relevant. These are strategies to manage complexity in different contexts, particularly those required by sustainability. The complexity managed by an enterprise emerges from key *complexity drivers or variety operators* closely related to an enterprise's technology, which needs to account for evolving environmental pressures. These models refine the technological models to account for product types, geography, market segments and time in different environments. And, it is only when the system in focus evolves towards an *extended enterprise*, that is, *when the enterprise evolves towards a new ECM, which bridges the complexity gap emerging with its problematic environments, that the enterprise is measuring operationally its relevant environmental complexity. This is a reflective process in which both the enterprise and the ECM co-evolve.*

An enterprise with product *design* capacity may subcontract product *manufacturing* to others, adding to its capabilities. This is a typical case where the organisational system, as an enterprise complexity model, is different to the *design enterprise*. In fact an enterprise's strategies to produce a transformation can be many. The technological and structural models in use are co-evolving with new technologies and emerging environmental constraints. At any time, current models can be superseded by ingenious new forms of producing the transformation. Each time this is the case the enterprise may take different decisions about the structure and relationships to produce a transformation, perhaps creating a different, innovative, *organisational form*.

From the perspective of complexity these decisions imply the selection of *variety operators* for the enterprise (Espejo, 2015 b). The design and selection of these operators is particularly relevant in today's globalised and environmentally sensitive, societies. These operators define an enterprise's new strategies to produce and make available their products and services, intertwined with the technologies-in-use. Each of these decisions generates complexity that the organisational system needs to contain structurally in ways that enhance its capacity to respond to environmental pressures. The current pandemic (COVID-19) offers an instance of mismatches between variety operators; the diagnostic tests necessary to work out numbers of infected people, and also numbers of people already possessing antibodies, seem to be out of sync with the operational capacity of health services (capabilities of hospitals and social services) and beyond the government's strategies for economic recovery. Increasing hospital capabilities, to receive infected people, requires amplification of hospital variety. At the same time, learning about infected people and people with antibodies requires reducing the variety of the overall population to those at risk and those with limited risk if they remain at the front end of health and other economic services. The overall performance to counter the COVID-19 pandemic requires managing the balancing of ongoing interactions between people in the community and health services, that is, between people demanding services (amplifying demand) and health delivering services reducing the variety of these needs

(attenuating demand). As the Viplan Methodology suggests, structurally this implies going beyond the health service to create a much larger organisational systems, enabled by powerful scientific models and by autonomous units, within autonomous units (i.e. *a recursive structure*). As for economic recovery similar considerations are necessary.

Following earlier arguments, for a *lead enterprise such as a National Health Service, variety operators* are other enterprises, better scientific models and communication and management systems to produce a cohesive and adaptive organisational systems. This is a heuristic in the generation of ECMs. As new technologies and scientific models suggest alternative structural and technological models, most likely their structural mapping will require an alternative unfolding of complexity and new considerations about the distribution of autonomy and discretion (Espejo and Reyes, 2011). These are platforms to work out necessary structural changes using the VSM and the Viplan Method. In the extreme these new technologies may show that the current transformation of an enterprise is unviable, suggesting that before reconfiguring its resources, it may need questioning its identity and purposes altogether.

Reconfiguring resources and relationships for new ECMs

A general strategy to close the complexity gap between and enterprise and its environment is reconfiguring resources, relationships and interactions (Teece 2008, Eisenhardt & Martin, 2000). This strategy is closely related to the unfolding of complexity and the decentralisation or centralisation of resources and functions.

With current technology and scientific models, it is possible to have resource centralisation, using scarce specialised resources, and functional decentralisation for service delivery. This is a case where technology permits centralising product creation and regulation, thus gaining the advantage of scarce expert resources, at the same time of decentralising less specialised resources for service delivery (Christensen, et al, 2009 illustrates this situation for health services). What makes this situation consistent with the heuristic of pushing down complexity unfolding is that technology allows linking specialised centralised resources to local service delivery groups through *virtual autonomous teams* (Bowling and Espejo, 2000).

ECMs offer different strategies to manage an enterprise's complexity, such as it is the case with the National Health Service in the UK, experiencing COVID-19. New scientific models and technologies are changing the nature of these enterprises. From the point of view of attenuating the pandemic, people's distancing has been driven by scientific models, and the construction of new health facilities has been driven by amplifying building complexity through new technologies. In these cases key business functions such as finance, sales and marketing are likely to remain centralised reducing the scope for entrepreneurship at lower structural levels. In this example, at a first glance, the unfolding of complexity is likely to be skewed towards the top. In other words the scope for local autonomy appears to be restricted by the product and its technology. However, this needs not be so. Similarly, these local enterprises might well be networks of more specialised enterprises, whose viability is equally necessary, and so forth. This ECM is very different to that of a large all-embracing enterprise, which in the extreme conflates enterprise and organisational system.

These examples highlight the amplification and attenuation of an enterprise's complexity driving the emergence of an ECM. In the NHS's case, it is clear that in addition to the amplification of its activities it needs attenuators of environmental complexity. Without effective means to reduce undesirable local variations as a result of people´s behaviours and resources (i.e. people's distancing to 2m.), that is, as a result of weak amplification of

government's policies to attenuate local communities' behaviours, the overall performance of the NHS and society suffers (i.e. more infections and deaths). This latter aspect shows that developing mechanisms for organisational cohesion, which respect the autonomy of their suppliers but also standardise their products, are necessary for services viability. Furthermore, it needs to manage relationships between subcontractors, customers and a range of other agents. Developing an ICT platform, such as blockchains (Tapscott and Tapscott 2016), to manage an extended value chain is a powerful attenuator of environmental variety, which not only standardises interactions but makes them more trustful. The more the NHS and its regional and local units enable direct interactions among local suppliers and between these and people in the community, the more of its environment's relevant variety will be absorbed in the environment itself, reducing the residual variety that the Government and the NHS as a totality needs to manage directly. Similarly, there are a range of variety operators that the NHS needs designing in order to have an effective ECM. Also, it needs making viable its own enterprise transformation; that is, its orthogonal transformation to those transformations of the hospitals and services constituting the organisational system it leads. Say, it needs capacity to create, design and implement networks (i.e. its own primary activities) to support local clinical services, which are the platform for the ECM own learning. These platforms are its strength and also its Achilles heel. It offers the strength of the great flexibility to reconfigure resources and develop new capabilities should the circumstances so require, but it has the challenge of building up relationships with distributed enterprises which use different standards and make, among other aspects, more difficult complying with safety and security requirements.

ICTs are changing the nature of organisational interactions. This is an issue that commentators have related to the surveillance capitalism and society (Zuboff, 2019). Relationships and interactions dominated by high cost technologies, only accessible to a few, are likely to reinforce centralised relationships. On the other hand, distributed technologies, such as Microsoft Teams, Skype, Zoom, can support distributed, but also demanding, relationships. Information technology enterprises are changing interactions between customers and suppliers over time. The social steering of the government coupled to those services like those that the NHS needs implementing, supported by ICTs and innovative organisational models, enable increasing the effectiveness of the relationships between health services and customers. Developing and maintaining these digital platforms appear to be the challenge for the NHS, which add significant value to sorting out people´s needs and defining its core competencies.

One of the NHS core competencies *should be* developing and maintaining web applications and logistic networks to relate people to its local services. A more hierarchical model would require a large number of intermediaries and distributors. However, its current problems suggest that the ECM of the NHS needs to be reinvented continuously and, for instance, blockchains may be offering this opportunity.

ECMs in the economy, such as that led by the Bank of England in the UK, will have to experience much change, reshaping economic relationships to overcome inequality, poverty and recession .

A focus on interactions and communications among producers *is an ECM for regional and local economies*. Clear local policies and flexible technologies make possible the development of enterprises as clusters. Today's ICTs, more than ever before, allow the clustering of several enterprises in one organisational system. This was the goal of an EU project about Digital Business Ecosystems (Nachira, et al. 2007). This project made clear that open source software allowing Business to Business commerce (B2B), Enterprise Data

Interchange, (EDI), internet integrated Computer Aided Design (CAD) and so forth were infrastructures or enabling technologies for new economic models, less reliant on free markets. In today's situation government institutions, like the Bank of England may provide the leadership for viable clusters. These efforts to enable clusters to align their interests with relevant national, regional and local institutions, require that the participating enterprises develop relationships of organisational citizenship (relationship (6) in figure 2).

In the context of the Viplan Methodology, the Viplan Method is a tool for modelling the distribution of functional resources in an ECM. From the perspective of the ECM this method is an instrument to test whether better management and organisational practices, including new technologies, permit a more effective distribution of resources and problem solving.

ECM and Performance

The extended enterprise's performance is the acid test for the adequacy of enterprise's strategies to manage complexity. An ECM, as a tool for governance, is a tool to adjust/change the enterprise's structure to develop its performance. These changes are driven by many factors, but most importantly, by the purposes of an emerging ECM, as it changes policies and also as it makes use of new communication and information technologies. Thus, as an ECM unfolds, it is necessary to observe how technologies alter communications between environmental agents and actors of the organisational system. Is the enterprise developing adequate capabilities to build up its intended ECM in an uncertain environment? Maintaining an adequate performance in a dynamic environment requires constant structural adjustments. The ECM, as a model of the structural strategies to manage complexity, helps working out improvements, small and large, in the enterprise by developing communications and reconfiguring the distribution of resources.

The ECM is a dynamic model that has as a starting point the current situation of an enterprise (inner loop in Fig 2), whose response to its total and problematic environments is reflecting its current performance. The enterprise's performance is measured by the reflexive nature of its current achievements and latencies as it develops its communications with agents in the environment. They are depicted in figures 1 and 3 by relationship (1) -with the total environment- and by relationship (3) -with the problematic environment. Key performance indicators are used to measure this performance. The current enterprise has actualities -what it does today-, capabilities -what it could do today if it improves its current structure-, and its potentialities -what are its latencies in the environment (Beer, 1981). *An ECM is a way of giving a structural expression to this potentiality.* As the enterprise in focus evolves into an ECM, this model becomes the enterprise's potential performance. Its realisation has actualities, capabilities and potentialities, but now the focus is on the complexity of communications rather than on the products or services (Espejo and Dominici 2016) of an still evolving enterprise. In this context a*ctuality* is measured by the relational complexity of the current communications of the enterprise with its agents, *capability* is measured by the complexity of the communications that the enterprise could match in the environment, with proposed technologies and competencies, and potentiality is defined by the latent complexity of its communications with agents as emerging from technologies, in the problematic environments. This is the complexity implied by the ECM, which reflects the extended boundaries of the enterprise and its *potentialities*. To deal with this complexity the enterprise needs investing in new technologies and developing new structures. Achievement structurally relates to the enterprise's *achievement relationship* (relationship (1) in Figure 3); is the enterprise matching the communication demands of its intended network? Latency structurally relates to the *stretching relationship* (relationship (3) in Figure 3); is the

enterprise aware of its communication latencies, that is, how much more it ought to develop its communications to transform itself into an operational ECM? Is it exploiting the opportunities offered by the problematic environment? Is it developing its capabilities? And the *performance relationship* relates to the extend the ECM is bridging the organisational system's complexity gap with its sustainable development goals.

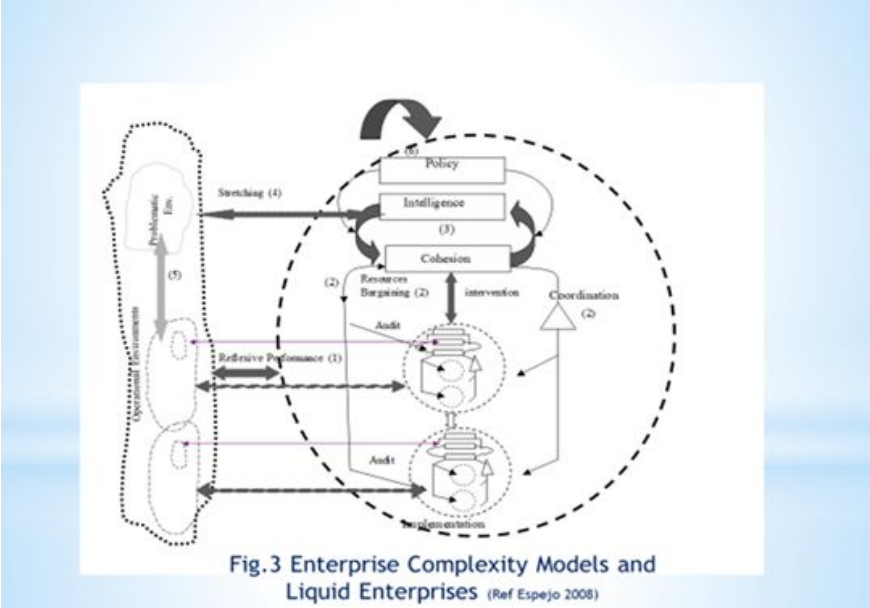


Fig.3 Enterprise Complexity Models and Liquid Enterprises (Ref Espejo 2008)

The structural aspects of these communications can be appreciated in Figure 3, which guides the practical development of the ECM. Improving an enterprise's performance is the purpose of the cybernetic (inner) loop in Figure 2. It requires bridging its self-defined complexity gap -or potentiality- with environmental agents. For this it needs capacity to assess current capabilities and the resources necessary to develop new capabilities. The ECM models strategies to manage the complexity of environmental agents' communications starting from the enterprise's current *organisational structure.* The better is this structure the better is likely to be its appreciation of the problematic environment and the clearer are the opportunities to develop the enterprise towards a selected ECMs. The challenge is dealing with the communications implied by new capabilities. The *inner loop* of the Viplan Methodology offers a heuristic to diagnose and improve the current enterprise's structure. Additionally, developing the enterprise towards its ECM requires seeing *reflexively* the enterprise as part of a *development loop (i.e. outer loop* in Figure 2*)* defining and creating new communication capabilities. This is a learning loop whose purpose is appreciating in conversations with environmental agents, that is, with those affected and affecting its sustainable development goals, alternative problematic environments and visualising latencies for developing new communication capabilities. These are potentialities for the enterprise and point at the resource requirements and their configuration to develop the enterprise implied by its desired ECM. Developing these capabilities imply investment programmes and structural changes. An ECM's *development loop* uses the interactions between the enterprise and its environmental agents to work out new capabilities. It helps clarifying strategies to manage environmental complexity based on ICTs, scientific models and related technologies. It helps bootstrapping new policies to an existing organisational structure that makes possible the development of new capabilities.

Considering that the communication complexity of an ECM is the enterprise's potential variety, managing its relational variety with that of the environment's sustainable development goals, requires:

1. "Attenuating environmental variety without killing it". This strategy has the potential of increasing the appreciative complexity of the sustainable development goals by fostering policies that increase the self-organisation and self-regulation of the targeted environmental agents, but, and this is an important caveat, self-organisation and self-regulation deal with most of the variety within the environment itself -reducing it vis-à-vis the enterprise's variety, thus decreasing the residual variety that needs the enterprise's attention. Indeed, the very same communication technologies can help to do this.
2. Amplifying the enterprise's variety through collaborative enterprises building the ECM; these collaborative enterprises increase the enterprise's variety as they align their doing with the enterprise's transformation. They constitute the evolving innovative ECM; they communicate the enterprise's potential variety to the environment in need of sustainable attention.
3. Managing the residual variety left unattended by agents in environmental that requires the enterprise's attention, by using variety attenuators, such as information filters, communication devices and so forth.
4. The above three strategies are part of enterprise's *variety engineering vis a vis its environment to achieve adequate performance*. Thus, the attenuation of environmental complexity is done by collaborative enterprises and resources as their interactions evolve with environmental agents. A purpose of the ECM is offering ingenious variety engineering strategies (Beer, 1979, Espejo and Reyes, 2011) for the enterprise to manage environmental complexity and to develops new capabilities. To check whether the variety engineering model is adequate it is necessary to assess whether the complexity management strategies are balanced regarding amplification and attenuation of varieties. For instance, an enterprise's attempt to develop a network may increase environmental agents' awareness of its services. However, if this amplification triggers a demand for communications that the collaborative enterprises are unable to respond to, then the development of new communications may not succeed. The enterprise may develop strategies and tools to improve agents' willingness to produce services by themselves in the environment, but, if after these changes the enterprise still does not match satisfactorily the building up of communication requirements, it may experience a backlash; the enterprise did not pay enough attention to balancing amplification and attenuation. It is failing to achieve adequate performance. These are learning models and therefore need to be in constant evolution supported by new scientific models, technologies and possibly social networks to allow the enterprise to monitor its achievements, latencies and performance.

From the recursive nature of the VSM it may be expected that the evolving ECM will contain primary activities beyond the enterprise and become particularly significant in the management of environmental complexity.

Coda

The strategies that an enterprise like a country's National Health Service uses to create, regulate and implement a new transformation in a problematic situation, like COVID-19, depends on social, cultural, economic, technological and other factors, whose relevance emerges as it co-evolves with relevant environmental agents, such as people in the community. *As environmental pressures increase an enterprise can vary significantly the configuration of its resources, including those implied by the ECM, and this can happen in a*

relatively short term. It is apparent that the days when a particular configuration could remain unchanged for long periods are over and flexibility is critical for viability beyond survival (Espejo 2008).

Enterprises are constantly experiencing significant changes in their environments. Ingenuity in managing the complexity of their relationships is fundamental to success. New digital technologies offer possibilities for multiple complexity management strategies, which are changing the nature of organisations. The industrial economy of the 20th century is being superseded by the network economy of this century (Benkler, 2006, Schwad 2017). This change is transforming the strategies to manage complexity. Creative forms to match the requirements of an enterprise are emerging every day. From the rather centralised design, production and distribution of products of the industrial economy of the past century, to today's service economy underpinned by artificial intelligence and communications, new centralised and decentralised organisational forms are becoming possible. The Enterprise Complexity Model is proposed as heuristic to manage this transformation.

Dynamic enterprises depend on networks and other resources to reconfigure their structures and reduce response times; these networks and resources make possible the production of demanding services, quicker and closer to customers. They are less interested in production processes from 'nuts and bolts' to finished products; globalisation is making this ineffective. This new kind of enterprise may decide that it is more challenging and effective to manage the *communications* that are necessary for an effective value chain with related enterprises than to manage the production and distribution of services by themselves. For *alternative innovative transformations* it is possible to produce a wide range of enterprise complexity models, which may support reconfiguring the enterprise's resources and from the emergence of different capabilities in collaboration with other enterprises. An ECM transforms the resources, communications and interactions of the an existing enterprise. Supported by the Viplan Method, technological and structural models help hypothesising new unfoldings of complexity and distribution of resources. The Viplan Methodology recognises that these models are platforms for discovering latencies and for innovative implementation (i.e. for bridging the enterprise's complexity gap with its environment).

They provide the platform for developing communications and eventually for hypothesising new unfoldings of complexity. For an enterprise as already said, its primary activities are less likely to be those producing its services, which can be subcontracted, and more likely enabling communications and relationships between them and suppliers, customers and other agents. In the latter case the enterprise is servicing its customers with the services named in its identity but 'its doing' is managing the communications between them and their customers, suppliers and other agents through enterprises beyond their boundaries. Primary activities for this enterprise, in this case, may be internet based ICT platforms to enable the communications entailed by the value chain. For a public sector institution like the NHS, similar considerations may apply; rather than providing traditional services directly, public institutions may manage the communications of public-private partnerships (PPPs) to provide them. What is particular to these situations is the ingenious use of digital technology and scientific models to increase performance and competitiveness. For a wide range of industries such as publishing, transportation, retailing, marketing and most importantly health, the potentials of digitalisation are indeed enormous (the 4th Industrial revolution). In all these industries enterprises are developing innovative *communications* with other enterprises and suppliers and customers. These are strategies to develop *many to many interactions* between enterprises through distributed self-organising interactions, to make them more trustful and reliable. They need models to make easier and more cost-effective the *matching of*

complexities in these interactions; new technologies are opening the space for *these matchings, and are offering opportunities for ECMs.*

The enterprise's ECM, that is, its strategy to manage relevant complexity in highly dynamic niches/markets may require, reflexively, an on-going reconfiguration of resources, communications and relationships to produce a more responsive organisation. The problem solving heuristic of the Viplan Methodology emphasises the capabilities of the *network economy*. The enterprise models of the industrial economy need to be replaced by network models underpinned by digital platforms. The challenge for enterprises is transforming their old industrial economy based models into network economy models that make use of new opportunities. Clustering the activities of small enterprise or individuals in different configurations can produce much more fluid, liquid organisation structures (Bauman, 2000, Espejo 2008). The cybernetics of the network economy supports decentralisation and fluidity in ways that the industrial economy did not. Martin Luther's Church reformation in 1517 was enabled by the invention of printing, which weakened the power that the Church had over information and knowledge production in Europe. Equally ICTs in the digital economy have the potential of weakening the power of large enterprises to the benefit of the more talented people. Our increased autonomy and in particular our capacity to do more by ourselves, makes it possible to increase the use of self-organisation and self-regulation in the environment to the benefit of social, environmental and economic enterprises. These facts, emerging from the network information economy, can influence enterprise models to drive today's activities.

In summary, the Viplan Methodology offers a learning platform to develop an enterprise's latencies towards dynamic capabilities. The Viplan Method offers directions to design effective structures. The variety engineering model is used to model communications and interactions between enterprises of all kinds.

This paper has proposed a methodology to develop an Enterprise Complexity Model (ECM), which is visualised as a distributed governance model of an ecology of evolving enterprises. Governance is understood far beyond directing development; it is understood as guiding the ecology of the enterprises' collective self-organization. The challenge is steering their self-organization towards values and policies creating, regulating and producing products and services that are deemed necessary to handle societal problems like COVID-19 in general and for the global economy. This view of distributed governance includes enterprises at all levels, from the most local to the most global. Governance is focused on processes aimed at innovation as well as making things happen today.

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