Decrypting the DNA of Megaprojects

A Model-based Management Approach using the Viable System Model (VSM) [1]

Michael Frahm and **Dr. Martin Pfiffner**

Abstract

The following article is an introduction to the design of megaproject organizations based on the viable system model. It combines approaches from project management with approaches from systems theory. The understanding of complexity and how it is effectively managed by the organizational code is a central theme. After referring to current research and a short introduction, the application is shown by using an example. The article shows how important the „applied“ management model is for a successful management of mega projects.

Keywords: Majorprojects, Megaprojects, System Theory, Viable System Model, Organisation, Complexity

1. Introduction

Megaprojects are complex organizational structures that significantly influence both their parent organizations and their environment (Müller, Drouin and Sankaran 2020). Regardless of which criteria are used to measure their success, such projects are extremely complex (Hu, Chan, Le & Jin 2015; Pitsis, Clegg, Freeder, Sankaran & Burdon 2018), which makes their management very difficult (Shenhar and Dvir 2007; Söderlund 2010). But how can we understand them organizationally? One analysis (Lundrigam, Gil & Puranam 2015) suggests that mega-projects can be understood as a hybrid form of meta-organization. Accordingly, megaprojects are pluralistic hierarchical mixed systems, which have both closed and open system properties and are divided in their core and periphery. A central question here, in the context of performance, is the distribution of power or hierarchy and the functioning of the information and decision-making processes in the system. Denicol, Davies & Pryke (2021) propose that megaprojects be conceptualized as dynamic production systems and built and developed in a life-cycle oriented manner. They also emphasize the importance of viewing the organizational

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elements of megaprojects through a systems lens in order to develop solutions for improving their performance. Denicol, Davies and Pryke (2021) developed a conceptual framework for this, called Project System Organization (PSO), which gives fundamental guidance on how to organise a megaproject's structure through its lifecycle.

Following the work of Lundrigam et. al (2015) an approach is needed that maps both closed and open system characteristics, the distribution of power and hierarchy, and the functioning of information and decision-making processes in organisation. Following Denicol et. al. (2021) it is important to view the megaproject organization through a system lens to understand them and improve their performance. The need for this systemic perspective in project management was also emphasized by other scholars (Müller, Drouin, and Sankaran 2019; Tannir, Mills and Krystallis 2019; Jaradat 2015). The model-based management approach which the authors will present with this article can meet the above required demands (Lundrigam et. al 2015; Denicol et. al. 2021) and answer the question in the organisational dimension at any scale and thus provides a blueprint for organisational design of megaprojects through a systems lens.

The organizational management can only be as good as the model on which it is based. The Conant-Ashby theorem (1970), also known as the good regulator theorem, states that every good regulator of a system must be a good model of that system, and that this model must be rich enough to be able to explain what really matters. The authors argue that Stafford Beer's (1959, 1972, 1979,1984, 1985) Viable System Model (the VSM) is just such a rich and suitable systemic model of organizational design and complexity management (Espejo and Reyes 2011). It is an effective model for diagnosing, designing and managing complex systems, including megaprojects (Bourne 2019; Tannir, Mills and Krystallis 2019; Sankaran, Müller, Drouin 2020). In this way, the gap in the lack of holistic traditional hierarchical approaches from project, program and portfolio management can be closed by observing the success-critical aspects of organizational design and governance from a systems perspective (Müller, Drouin and Sankaran 2020; Lewis and Millers 2009)

Below, the VSM is applied to diagnose the organizational structure of an example megaproject, based on a real megaproject, through its construction phase at different organizational levels and from an owner perspective. It is argued that the functioning of complex organizations can be understood by decrypting their "DNA" at several management levels (so-called levels of recursion, as explained later), from their mother company through programmes and projects to subprojects. By DNA, is meant an organization's generic organizational code — or in other words, its structure, its processes, its communication, its control, its neurology and its coupling with the environment.

2. Characteristics of megaprojects

There is no international standard definition of megaprojects. Although not universally valid, some definitions offer helpful insights. For instance, Greiman (2013) characterizes megaprojects in terms of 25 criteria. These include for example:

- long duration (10, 20, 30 years or more)
- scale and dimension (1 billion costs or more)
- design and construction (superlatives, innovation, new land)
- partners and funding (very many)
- life cycle (monument, 100 years or more)
- project preparation (10–20 years approval phase)
- high public interest (stakeholders, citizens, media)
- much public control (technical, security, financial)
- no continuous management (management and staff fluctuations)
- urban development effects (climate, surface, cityscape)
- organizational structures (coordination, hierarchy)
- risks (extremely)

Flyvbjerg's (2003, 2014, 2017) rule of thumb roughly defines megaprojects as situated within the range of $1 billion. However, characterizing megaprojects (or very large projects for that matter) solely in terms of cost would be too simplistic. Other characteristics also need to be considered including difficulty, complexity, interfaces, location, environment, risks, duration, number of employees, novelty, approval authorities and stakeholders. Hence, while cost of capital provides some indication, context and the convergence of various factors are also relevant.

3. Why complexity matters

Dealing with megaprojects means dealing with the functioning of complex systems (Li, Han et al., 2019; Locatelli, Mikic, Kovasevic, Brooks, and Ivanisevic, 2017; Damayanti, Hartono and Wijaya 2021) which are also called systems of systems or array projects (Shenhar and Dvir, 2007). As Denicol et. al. (2021) stated "*Megaprojects are delivered through a combination of relationships between multiple organizations, creating a complex organizational challenge that is often underexplored in light of the technical specifications*." (p. 339) "*Megaprojects are complex system of systems*" (p. 340). Complexity and its management is seen as the main reason why megaprojects go wrong (Damayanti, Hartono and Wijaya 2021).

Complexity is viewed differently, reflecting its subjective nature (i.e., that it depends on context, actors and observers). Hans Ulrich (1988) distinguishes complicatedness and complexity from a systems perspective as follows: He associates complicated with the specific composition of the elements of a system, whereas complexity describes temporal variability and the richness of potential behaviour, which proliferate exponentially with the increasing interaction of elements. A complex system has an uncountable number of elements, relationships and possible states, which change over time and according to different dynamics. In megaprojects, as project-based organizations, these dynamics can sometimes be very fast, wicked and challenging (Miller, Lessard, Sakhrani 2017) and also over a long time scale and so a stable state becomes unstable fairly easily (Frahm and Rahebi 2021).

Complexity is measured in system sciences by the variety of a system, which expresses how many possible states a system can adopt (Frahm and Roll 2022). Measuring complexity is necessary for one of the most important laws of governing complexity to hold. This law, however simple it seems, is essential for the functioning of complex systems. It was discovered by the British neurophysiologist and cybernetist Ross Ashby (1956). Ashby's law says:

"Only Variety can absorb Variety".

This means that a system with high variety (e.g., the 11 players of a soccer team) can only be controlled by a system with at least the same variety (e.g., another team of 11 players). A megaproject often involves, directly or indirectly, over 10,000 people, sometimes a million or more other people are affected. This generates an enormous amount of variety. Megaproject organization must provide the means to absorb this variety at the right levels and to achieve and maintain a stable balance of its internal and external domains. It must be able to cope with the complexity confronting it. This law can be understood as a key principle of a systemic approach. It is considered to be as important for the management of organizations as Newton's laws of gravity is to physics (Beer 2001). Organizational Science has discovered other laws and principles of coping with complexity in the last 50 years (Hoverstadt 2022). These form part of the VSM, which makes it possible to diagnose and design a megaproject.

4. Why a model-based management approach?

As mentioned, the management of a megaproject can only be as good as the model used to control the situation (Conant-Ashby theorem). The variety involved in a megaproject must be reflected by the variety in the regulating managing system (Frahm and Rahebi 2021). Too many projects fail because they rely on outdated mental models (Denicol, Davies, Krystallis 2020). We need better models to help us break complexity down into manageable, self-organizing and self-coordinating parts and to reassemble them into a coherent whole. These better models must reflect project complexity and dynamics, the number of internal and external stakeholders and also their ongoing interactions and communications (Pfiffner 2022).

The predominant model of organizations in the past was the machine: A more or less complicated construction designed to perform a more or less well-defined task. We still use this model when drawing organizational charts and describing processes. But a machine does what it does. Its predetermined behaviour keeps its variety low. A model of much higher variety is the model of the living organism. It includes capabilities not found in machines, or only to a limited extent, such as the ability to adapt to fast-changing situations, to learn, to heal, to reproduce, to converse or even the ability to produce consciousness. This alternative model, the Viable System Model (the VSM), includes viability.

The VSM offers a novel perspective on megaproject organization: Organisms absorb complexity exactly where it arises (Pfiffner 2022). It is in their DNA, which has evolved and been optimized over four billion years of evolution. Only what cannot be absorbed where it arises is managed at a higher level. Organisms have the ability to react immediately (i.e. reflexively) to change. They have developed the control and communication structures needed to maintain inner and outer balance. These structures even allow human beings to consciously change their purpose.

A better organizational model (i.e. the organism) enables a better understanding of system behaviour, and hence enhances project stability and performance. The Conant-Ashby theorem and practical experience (see the practical example below) show that the proposed model (Beer's Viable System Model) can be an approach that makes it easier for managers to be successful.

4.1 Short Introducing the VSM

Today's management practice deals only with two of three organizational dimensions. The first dimension is the anatomy of the organism. We use organizational charts to represent the anatomy of the organization. We enter the names of the organizational entities (e.g., divisions or business units, steering and supervisory boards, finance or legal department) into the boxes of the chart. The second dimension is the physiology of the organism (i.e., the different processes and routines for breathing, digesting, sleeping, etc.).

As a rule, however, we neglect the third dimension: the neurology of the organism. This is the most important dimension in modern projects because it helps managers cope with complexity and dynamics. The neurology of the organism is its control and communication structure (Pfiffner, 2022). Crucially, it ensures that the organism — or the organization — remains viable, that is, able to lead a separate existence. Studies and experience show that the third dimension of organization — the neurology of business — is designed rather poorly in most organizations (Pfiffner, 2022).

Stafford Beer's "Viable System Model" (1972, 1979, 1985) provides the control and communication structure needed to ensure project viability. As such, it contains the necessary and sufficient elements for a megaproject to function successfully in the long run.

The model involves the environment as part of the system under control. The environment is represented by a cloud (see Fig. 1) because we cannot exactly determine where it begins and where it ends. It includes clients, cooperation partners, competitors, public authorities, stakeholders and so on. The environment contains our operation (i.e. our project), which in turn contains a management box. To describe the relations between these three basic elements, we draw them one next to another rather than embed them one within the other (see Fig. 1).

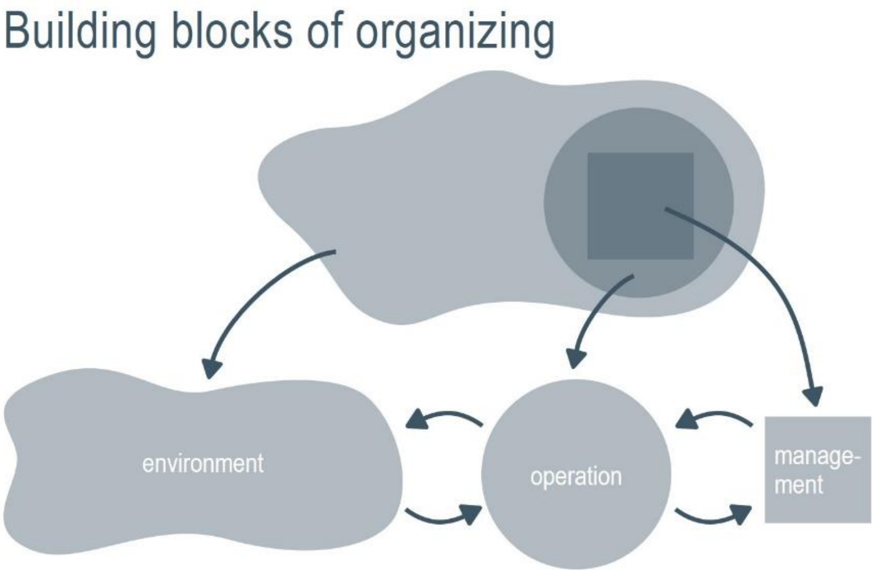

Fig. 1. System 1 of the Viable System Model

In megaprojects, multiple operations are running at the same time, in their own specific environments and with their own specific management boxes. Together, they fulfil the purpose of the whole project. They are the self-regulating entities that do what the owners/ sponsors/ clients have asked and paid for (Beer, 1972; Hildbrand and Bodhanya, 2015). We call them **System 1**.

By way of example, Fig. 2 shows four operations in System 1 (1a, 1b, 1c, 1d). The environments of these operations overlap. These overlaps reflect the extent to which the operations deal with the same clients, cooperation partners, authorities, etc. The orange wavy lines between the operations represent operational dependencies, which may arise, for example, from sharing resources (machinery, people, budgets, etc.).

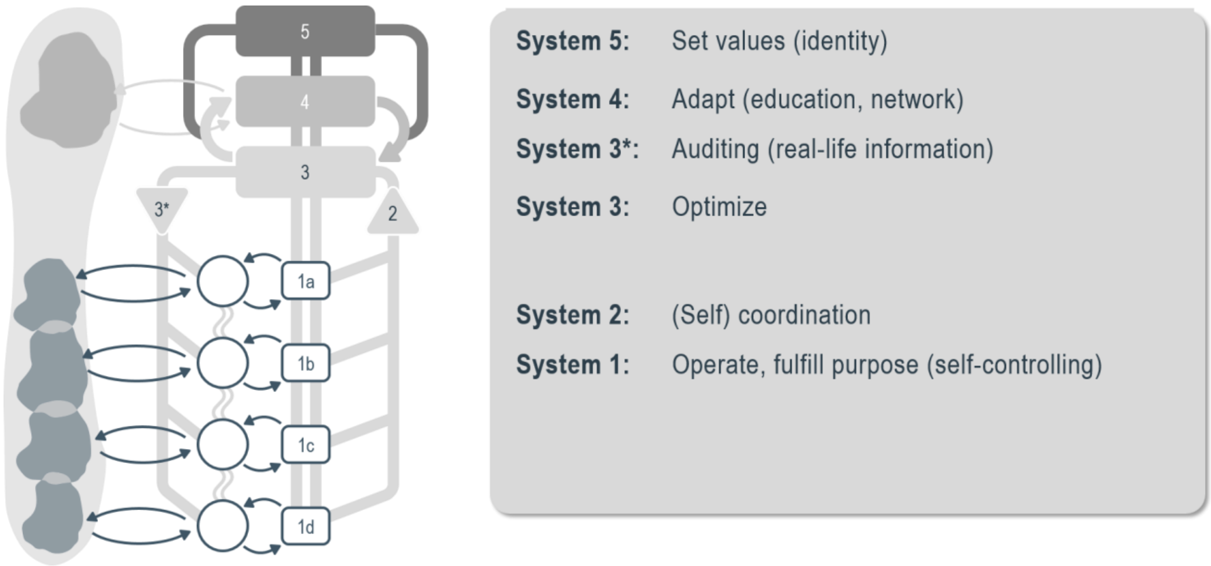

Fig. 2. Viable System Model (the VSM)

These overlaps (i.e., wavy lines) must be coordinated and managed in order to avoid conflict. To this end, the VSM includes a specific control function: **System 2**. This supports the operations (System 1) in their coordination efforts. A System 2 can involve rules and regulations, process descriptions, coordination meetings, shared services and much more, depending on the organization. It also includes elements perhaps less expected in an organizational chart, yet nevertheless important for success, such as a common language or a common culture. Although language and culture seem less relevant or common in organizational charts or process designs, they play an important role in the neurology of a system (Beer, 1972; Ríos, 2012; Pfiffner 2022).

Every operation (System 1) has its own management box and hence is able to optimize itself. A third control function, one overseeing and optimizing the whole project, is necessary. This is **System 3**. It sets priorities, (re-)allocates resources, exploits synergies and resolves conflicts (if not already done by System 2) for the benefit of the overall project. It has an "inside & now" perspective in that it oversees today's business and does everything for its success. But it takes only those decisions that cannot be taken at lower levels. In this respect, the VSM reflects the principle of subsidiarity and of relative autonomy: Decisions are only taken at a higher level when the lower level, which is closer to the matter, can no longer take them itself (Beer, 1972; Pfiffner 2022).

System 3 (i.e. operational management) has several communication channels at its disposal. These allow it to take well-informed decisions as well as to implement them even if they restrict the autonomy of System 1 (i.e. operations). These communication channels are shown as lines in the diagram (Fig. 2). For example, we see a System 3* on the left in the diagram with a communication line directly into the operations of System 1 (Ríos, 2012). This is an independent information channel for System 3, which enables it to know what is really going on in operations (whereas quite often the operational management is too far removed from events on the ground) (Beer, 1972; Pfiffner 2022).

Please note that we are talking about a control and communication structure here, and not about boxes in an organizational chart. In the VSM, we no longer enter names in the System 3 box. Instead, we ask a crucial question: What mission-critical tasks must System 3 perform, and who is involved? Quite often, the same person is involved in different control functions, and thus "wears different hats" (Pfiffner 2022).

Systems 1 to 3 are necessary but are they sufficient for viability? Another control function is necessary, one that deals with the overall environment of the organization. This environment includes all existing stakeholders as well as the potential opportunities and threats. It consists of a known part, which must be dealt with, and also of a largely unknown part, which must be explored continuously. **System 4**, as the "outside & then" control function, deals with both parts. It communicates with the overall environment, explores future scenarios (in politics, regulation, technologies, competitors, etc.) and develops strategies for dealing with them (Beer, 1972; Pfiffner 2022).

Special attention must be given to designing the interaction between System 3 (inside & now) and System 4 (outside & then). Especially in megaprojects, which extend over many years, the environment can change significantly (Frahm and Roll, 2022). It is not enough to simply anticipate this early enough. Rather, an effective balancing mechanism — between what is right for tomorrow and what is right for today — must be established. This is the adaptation mechanism in the organism as well as in the megaproject.

In case this balancing mechanism becomes unstable or unreliable, a **System 5** intervention might be necessary. Whereas we can call System 4 the strategic management of the project, System 5 reflects the normative management. This takes normative decisions on undecidable questions (either because we lack information or because we simply do not know). It also includes basic decisions with unlimited validity, so-called policies. System 5 defines the identity, the purpose or business mission and the core values. By taking normative decisions, it absorbs the last bit of complexity that has not yet been absorbed by System 1, System 2, System 3 or System 4 (Beer, 1972; Pfiffner 2022).

To the extent that these five control functions and their communication channels are sufficiently established, a megaproject is under control and viable, that is, able to fulfil its purpose. Note the two control axes in the horizontal and in the vertical domain (Fig. 3). Both axes are needed for a complex system to be viable. The horizontal axes represents the self-organization of the result-producing operations. They manage and absorb the largest part of the complexity in the system. However, the vertical control axis is at least as important as it ensures the cohesion of the whole and that the whole can be more than the sum of its parts (Beer, 1972; Pfiffner 2022).

A closer look at System 1 reveals one of the most important tricks of nature for dealing with complexity: the principle of recursion. Also found in mathematics or in art, this means that the same structure is repeated time and again on different levels. In terms of the Viable System Model (the VSM), the principle of recursion means that every viable system is embedded in a viable system and contains several viable systems (Fig. 3) (Beer, 1972; Pfiffner 2022).

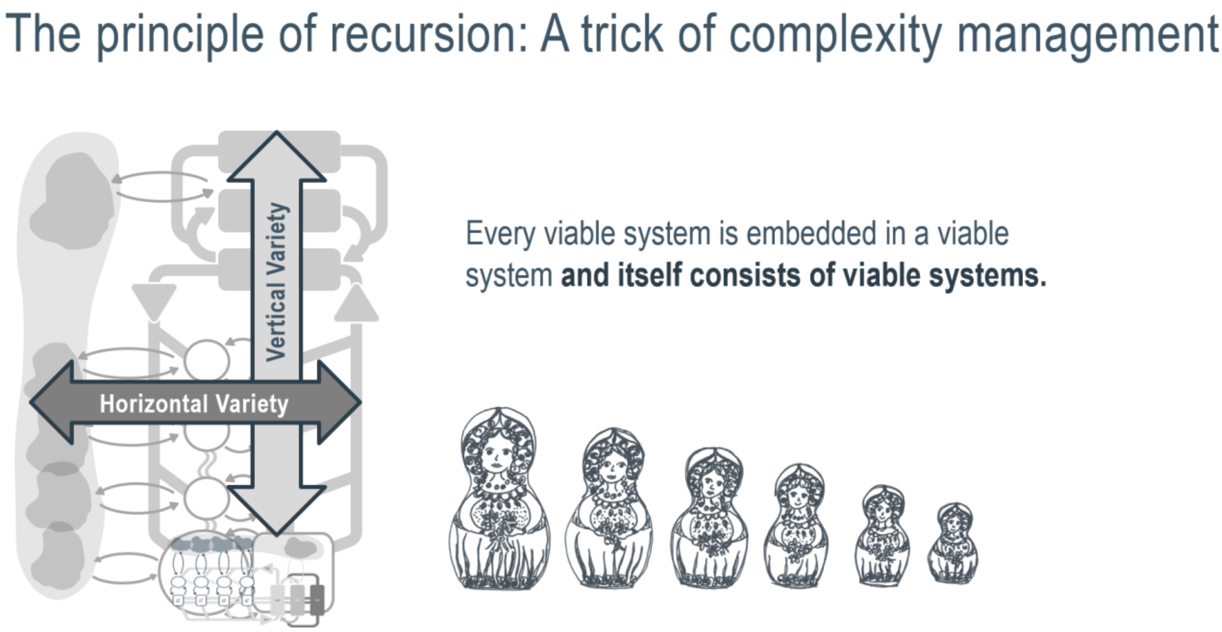

Fig. 3. The principle of recursion in the Viable System Model (the VSM)

4.2 Example Megaproject

To illustrate how to apply the VSM to design a megaproject, we present a single specific example (Siggelkow 2007) megaproject based on a real world German megaproject (Frahm and Rahebi 2017). The example should show that the VSM provides an effective framework for working with complex systems in practice. It also enhances the common understanding of organizational structures, processes, projects or matrix organizations.

Boundary conditions: The case is a megaproject with a budget of € 3 billion, which is presented from the owner's perspective. Spanning 20 years, the lengthy preparation period (including contract awarding) has now been completed and construction has begun. Our consideration is at this point. The megaproject is being financed by a consortium of private and public investors. Due to the large project volume and the associated risks, during the planning phase the client decided to establish its own project organization (PO) and realize the project through an owner-driven delivery model.

Fig. **4** shows that the project company is managed by three managing directors (chair, technical and commercial). The overall project is divided into several sections. Some sections are megaprojects in themselves. Each section is represented by a technical and a commercial manager with responsibility for results. In addition to project staff, coordination functions exist at the programme and project levels.

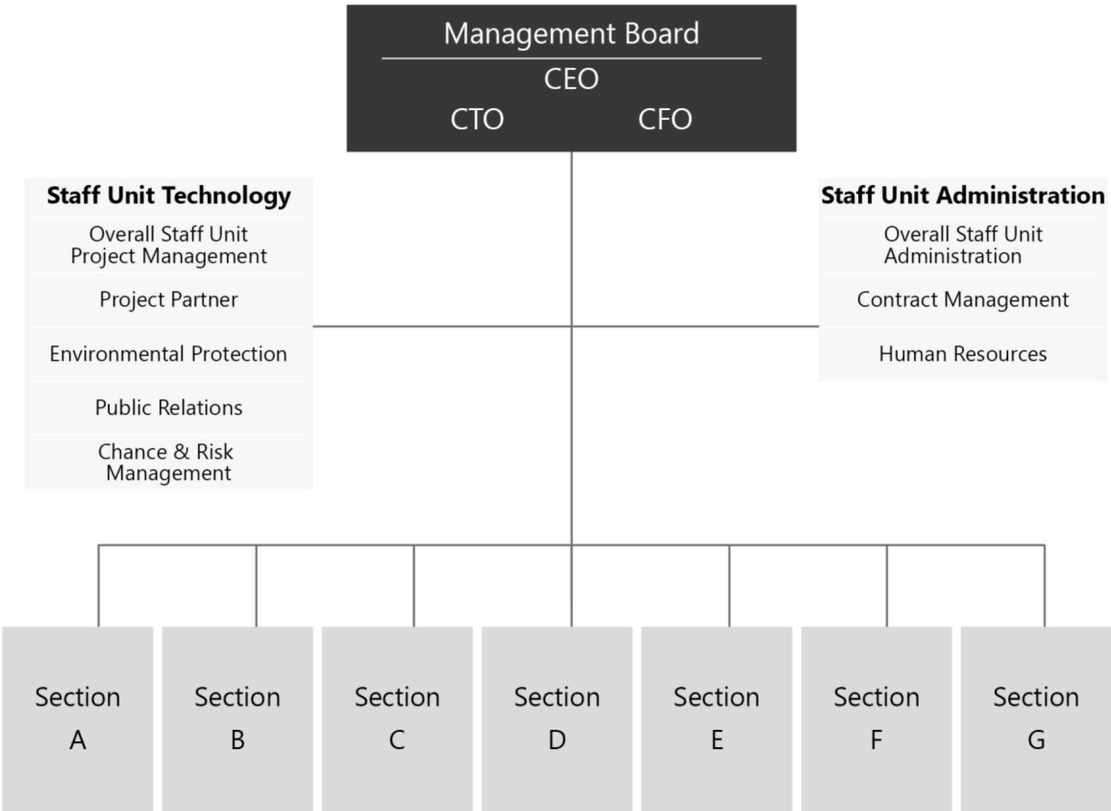

Fig. 4. Organizational chart

Fig 5 (below) demonstrates how the project organization (PO) of the megaproject fits into the "Infrastructure" division of its parent company and illustrates the principle of recursion with four levels of recursion shown. It also shows the permanent parts of the whole megaproject organization - with the parent company and the unit infrastructure - and the temporary parts of the megaproject organization - with the megaproject project organization and its sections.

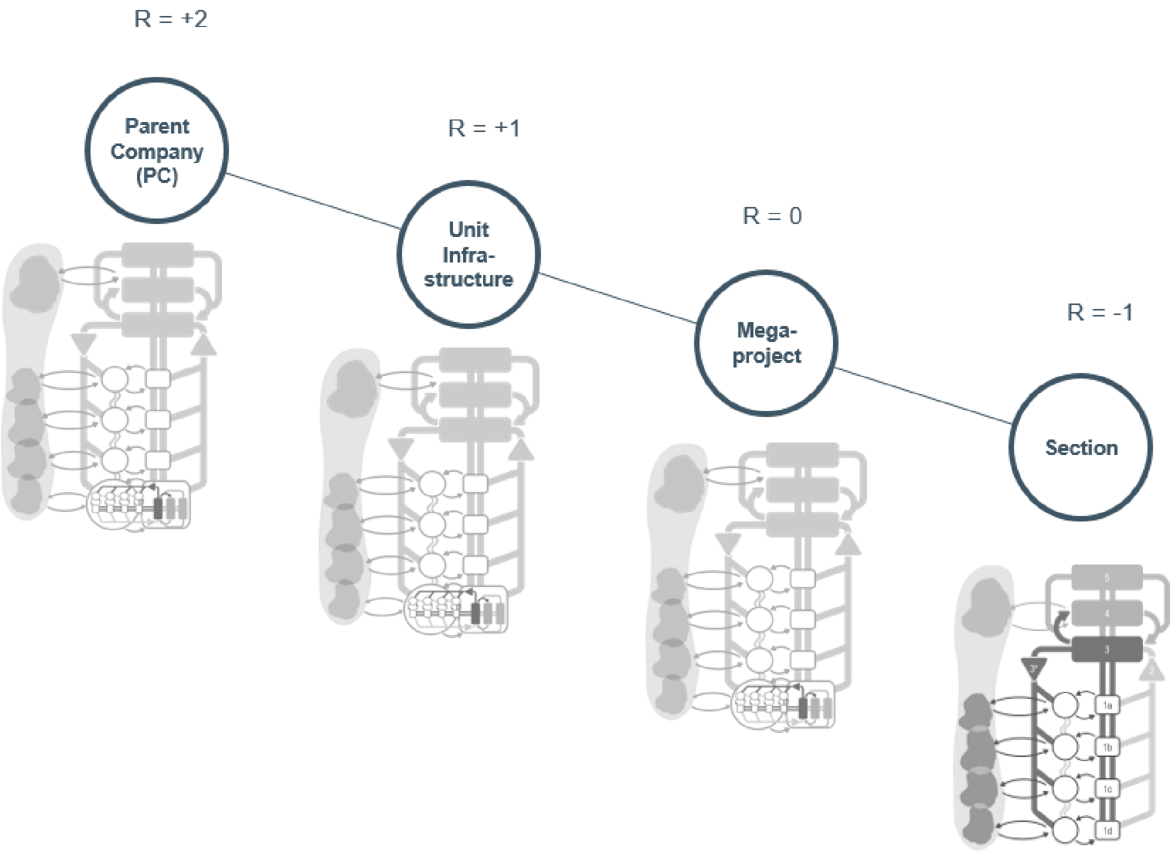

Fig 5. Overview with four levels of recursions

4.2.1 The organization as a whole

As with many large companies, the parent company (PC) (recursion level +2) consists of several thousand employees and consists of innumerable viable systems and many subsystems and producers. By way of example, Fig. 6 shows the Infrastructure Division, which carries out infrastructure projects, and the Passenger Transportation Division, which is responsible for transportation services. Both divisions are, by their very nature, interdependent. Many other existing organizational units are shown by two example placeholders.

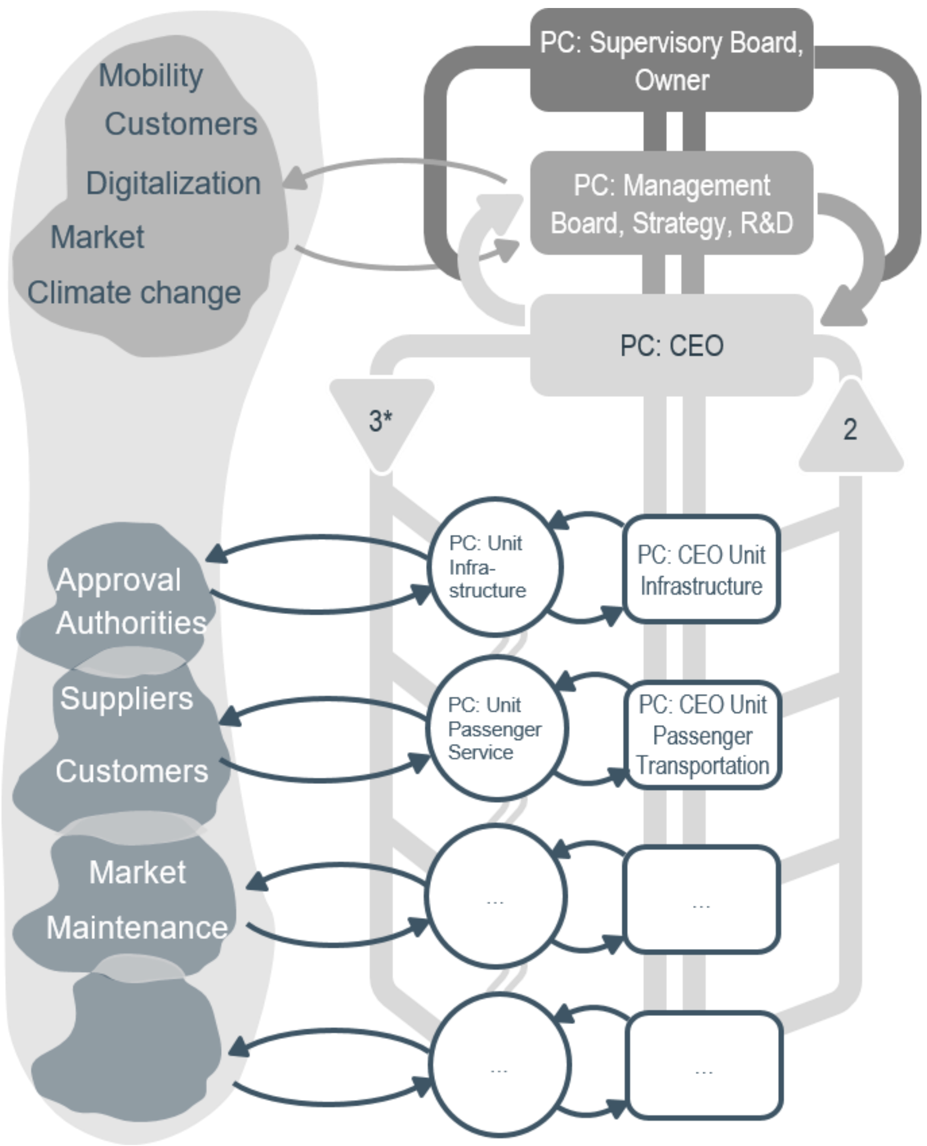

Fig. 6: Level of recursion R+2, the parent company (PC) "The Group"

Note: The VSM-style representation of the case organization is quite different from an organizational chart. It shows the control functions of the respective organs. For example, the supervisory board and the owners assume supervisory functions and thus fulfil the tasks of normative management. The owners, however, might also perform some System 4 tasks in certain cases. It is therefore important not to simply draw an additional organizational chart but instead to ask oneself whether the necessary control functions have been entered appropriately.

Fig. 7 provides a closer look at the Infrastructure Division (recursion level +1). Operationally managed by the CEO Infrastructure, this division comprises various activities. One of these, shown as System 1, is the project organization (PO) of the megaproject. Regarding the strategic environment: politics, market trends and the economy play a decisive role. The operational environment includes additional complexity drivers such as local and regional politicians, suppliers, competitors, potential customers and infrastructure project operators. This list of the complexity drivers is only an example.

In contrast to other megaprojects, which are implemented by the Infrastructure Division, the project organization in our case study has the advantage of being an independent company. This involves a certain degree of freedom in the area of operational and strategic decisions at the project organization level. Brookes (2015) states that 50% of all megaprojects are implemented by their project organizations and that this positively influences cost development and the stability of the construction schedule. Importantly, however, such an organization must be set up in good time prior to project commencement and adjusted according to project progress. Thus, personnel expenditure during planning is lower than during construction. Greiman (2013) concludes that a relatively autonomous project organization enables efficiently utilizing resources and recommends that an advisory board supports it.

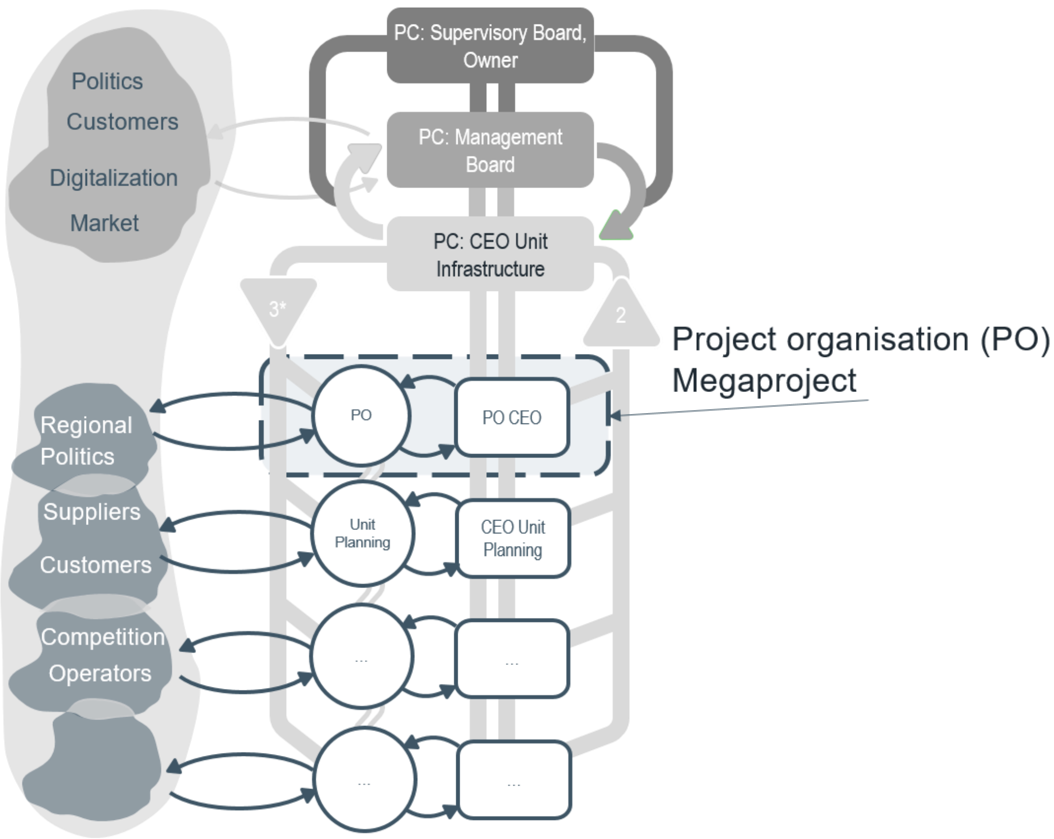

Fig. 7. Recursion level R+1, the infrastructure division

4.2.2 Analyzing the megaproject

The megaproject organization was analysed in two steps: (1) the overall project from the programme perspective (Fig. 8); and (2) the specific organizational considerations of Section A on the project level (Fig. 9).

(1) the overall project from the programme perspective:

Fig. 8 (recursion level 0) shows the overall structure of the megaproject. Derived from the higher levels of recursion, the supervisory board, and the chairman of the management board act as a normative element (System 5) embodying the values and guidelines of the parent company.

System 4, which deals with the strategic development of the megaproject, is represented by a three-tier team. The advisory board (consisting of experts) serves as a medium for best practice as well as to enable practical solutions concerning the long-term perspective. From a strategic point of view, the CEO infrastructure represents the interests of the parent company and takes into account the overarching objectives. The management board of the megaproject is responsible for implementing the strategies necessary for activities from the perspective of the megaproject and for incorporating the necessary information from operational management and production; they have functions both in strategic (System 4) and operational management (System 3). The operational management (System 3) consists of three managing directors. They are responsible for the organization, for resource provision and utilization, as well as for the operative implementation and performance of the overall project. Megaproject sections (also called subprojects) are often megaprojects or major projects in themselves, as is the case here. Section managers are responsible for their sections and can independently carry out day-to-day business and take operational decisions up to certain thresholds. Cyclical reporting is used to measure section performance.

In addition, various coordination units (System 2) exist at the programme level for the purpose of overall control. This makes it possible to manage overarching concerns and adapt issues and findings that affect more than one section. The cycle is closed by external audits (System 3*) at the programme level.

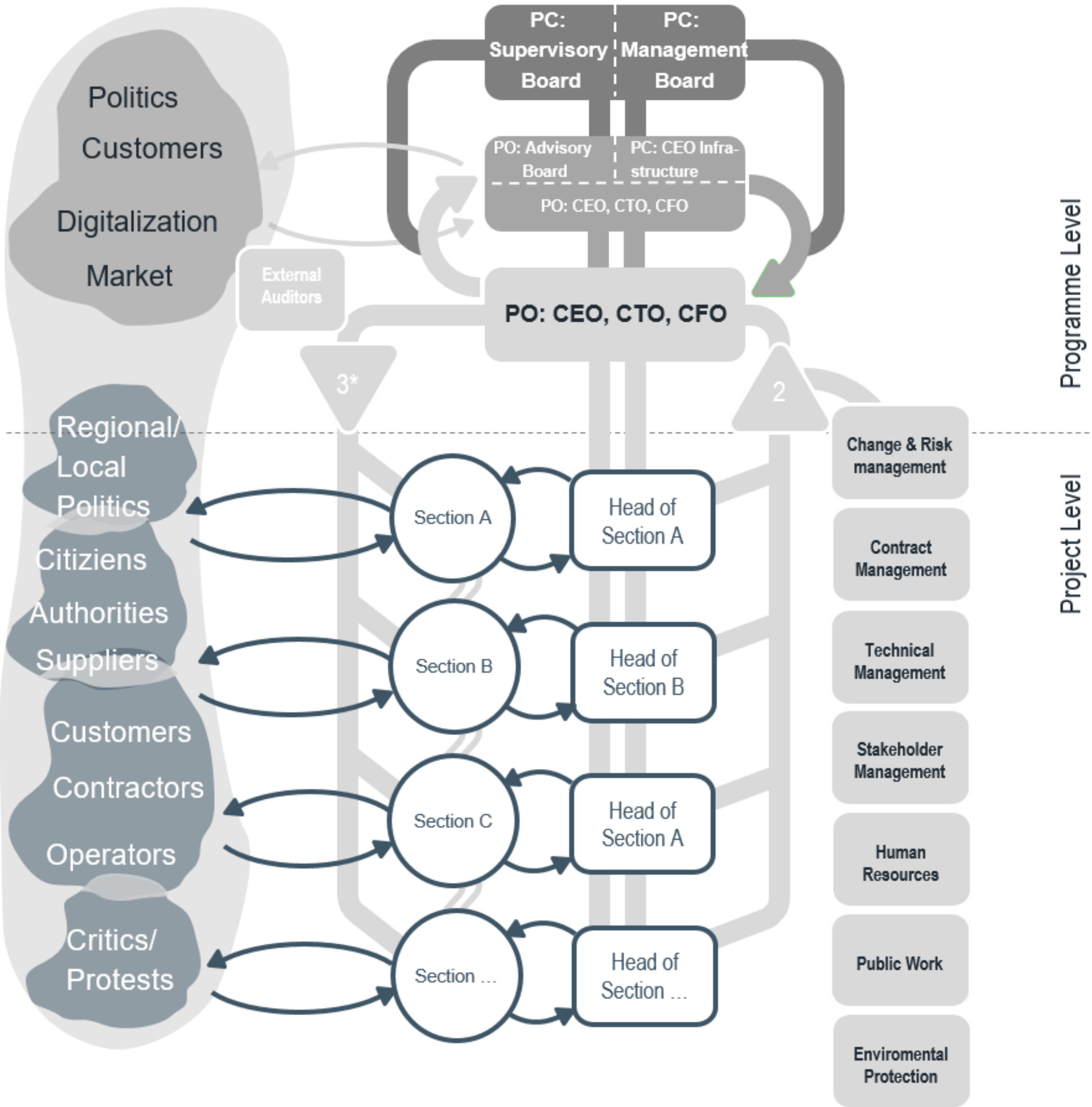

Fig. 8. Recursion level R0, the megaproject

4.2.3 Modelling of Section A

(2) the specific organizational considerations of Section A on the project level:

Fig. 9 shows the final recursion level (R-1) of Section A. Its project management establishes section-specific standards within the framework of its autonomy, as reflected in particular in coordinating and monitoring subprojects. Besides the overall coordination of staff units, Section A aims to establish its own culture, which promotes partnership with contractors and external stakeholders. For situationally appropriate coordination, workflow management instruments such as lean practices are used. Monitoring includes methods such as "management by walking around" or regular "coffee & issues meetings" for the exchange of and sporadic collection and verification of information.

Subprojects (Sections A 1, A2, A3) are similar in structure, with group leaders heading a team consisting of technical or commercial project managers, construction supervision and environmental managers. Group leaders are in close contact with each other and thus benefit from synergy effects so that subproject-specific coordination methods are identical across sections.

The primary complexity drivers of the organizational environment belong to three categories: public (e.g. authorities, citizens), building components (e.g. main contractors), and operators. Analyzing the communication channels shows that the project manual and contracts are fundamental for internal communication. On the environmental side, events that explicitly inform stakeholders about the project and involve them in the project have proven to be positive.

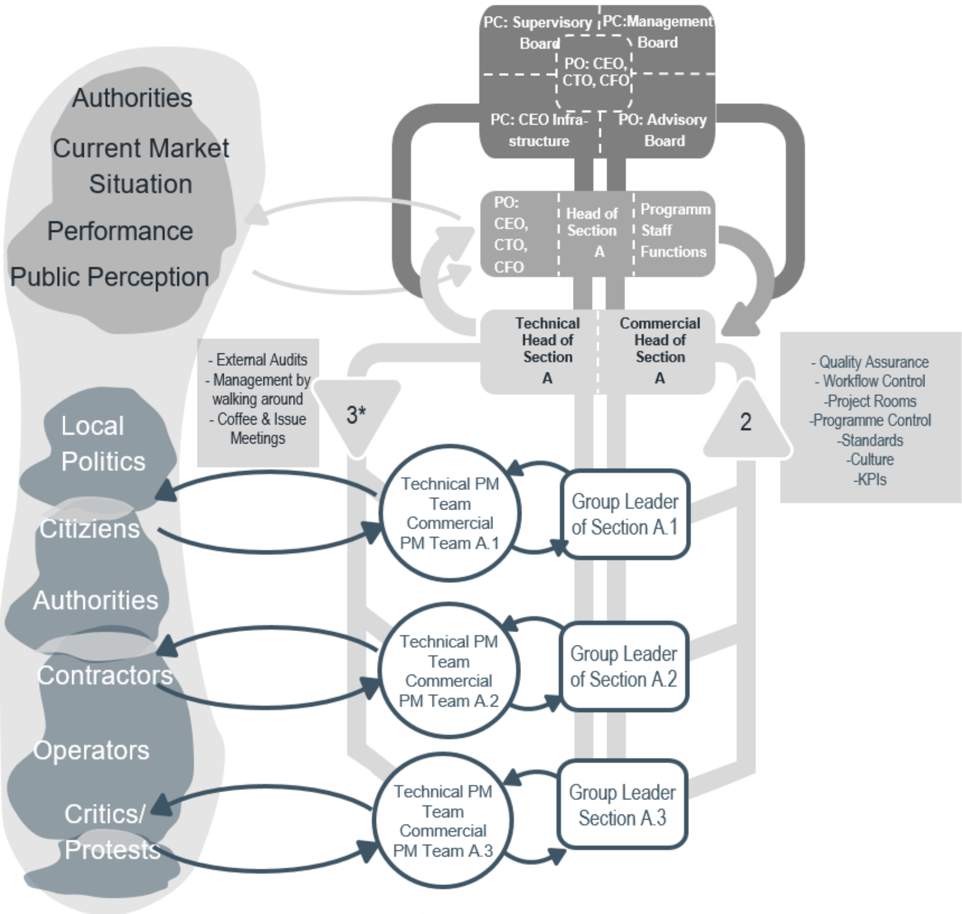

Fig. 9. Recursion level R-1, Section A

5. Discussion

5.1 Contribution

In this article, we have combined approaches and insights from megaproject science with those from systems science to bring the management of megaproject complexity to the forefront. With appropriate models there is a possibility to decode their DNA and build generic organizational codes which are able to face the arising complexity (Jaradat, 2015). There are other systems approaches that can be used for model building, an overview of which is provided by the system of systems methodology (Jackson and Keys, 1984). But in terms of structural complexity, the VSM is considered as the strongest approach (Hoverstadt, 2009; Jackson, 2003; Lassl, 2019; Pfiffner, 2022).

It was shown that the VSM is suited to identify and manage the critical control organization (3. dimension) of an organization. This is a key to manage complexity. With the VSM the previously highlighted requirements can be fullfilled; According to Lundrigam et.al., 2015 - Mapping of both - closed and open system characteristics (1) and Distribution of power and hierarchy (2):

(1) With the VSM, both internal (system 1-5) and external system elements (environments) can be represented. Due to the recursiveness of the VSM, this is scalable to any level with the same generic organizational code (Lassl 2019, Pfiffner, 2022).

(2) The functions of the VSM units ensure a homeostatic distribution of power and hierarchy. The VSM provides a complete blueprint (3. dimension) for the function of information and decision processes, which is scalable to any level of the system (Pfiffner 2022).

According to Denicol et.al. (2021) it is important to view megaproject organizations through a system lens for understanding them better and improving their performance (3)):

(3) The requirement a "system lens" is fulfilled, as the VSM is a strong non-falsified systemic method (Schwaninger and Scheef, 2016).

The PSO of Denicol et. al. (2021) shows the need for a framework and offers a fundamental inter-organizational canvas for megaproject organization. It is to be discussed whether the VSM presented here can be used in combination with the PSO. Both models have similarities in terms of layer structure (PSO) and recursive structure with self-similar character (the VSM). Used together, PSO could be used as a general model and the VSM as a detailed model of a mega project organization in all its temporal and spatial (e.g. technical and commercial) dimensions. This could provide a holistic systemic approach to design and analysis. Both approaches serve the need for analysis of project delivery models (Davies et. al. 2019).

Hence the VSM provides a unique blueprint for discussing and designing megaproject organizations. Even though this example represents an owner organization, the VSM can be used to represent the overall organization of all participants in the supply chain and thus also represents an adequate approach for aligning the interests of all participants in the supply chain over the life cycle (Turner and Simister, 2001; Frahm and Roll, 2022). This article contributes to the discussion of the inter- organizational structure of all participants and stakeholders (Winch 2014). Additionally, with the VSM it is possible to represent the approach of a own project entity for a megaproject (Gann and Salter 2000), also as the project network approach (Manning, 2017, Pryke, 2017) through its universal fractal structure.

The understanding of the organization is fundamental to designing multilayer, multilevel and multiphase supply chain architectures of megaprojects. With this article we provide a contribution to a better organizational understanding of megaprojects and concretize previous work through the example shown and the concrete application of the VSM to a megaproject (Müller et al. 2020).

5.2 Recommendation for practice

As described, the organizational framework plays a very important role when it comes to the success of megaprojects. The idea of how a well-functioning organization must look, i.e. the management model according to which the organization is designed, is crucial for success in practice (Conant and Ashby 1970). Structure, process and control organization are to be designed in the context life cycle in such a way that the organization can master the internal and external complexity. This task remains challenging throughout the course of the project.

The VSM is not there to draw an additional organizational chart. It is there to question whether the necessary control functions are adequately staffed. It provides a management model with which every member of a megaproject, from the employee to the manager, has the possibility of successful design and application. Or as Mike C. Jackson states (2003): *“A little knowledge of the VSM can take managers a long way. And it saves them a lot of time – no need to read any more about organizational theory: it is all here” (p.109).*

5.3 Limitation and future research

Research and application of the VSM in the context of megaprojects is currently still rare and limited. There are only a few known works that explicitly address especially this context (Müller et al. 2019, 2020; Sankaran et.al. 2020; Tannir et.al 2019). Further application in practice and further scientific assessments are necessary. Research questions to be answered in the future could be as follows:

- Do megaproject organizations and their performance benefit from a systems perspective and why?

- Is the Viable System Model as a model to manage structural complexity an adequate systems approach for megaprojects?

- How should megaprojects be organizationally designed, especially from a systems perspective?

Michael Pfiffner (2017) states that 71 % of strategic business crises can be avoided by applying the VSM. If this thesis is applied to megaprojects, the VSM is not only a crisis tracker but also an appropriate approach to organizational design.

The effects of the VSM on the performance of megaprojects remains to be investigated.

6. Conclusions

According to Greiman (2013), “When projects fail, all roads lead to governance” (p. 111) This quote highlights that closely examining organizations and especially their neurology over their life cycle is crucial, especially in the case of highly complex megaprojects. We began by asking how an organization — for instance, the structure, the processes and the neurology of a megaproject — can be successfully designed? We have suggested that the Viable System Model (the VSM), as a concrete application of Ashby’s complexity theorem, provides a valuable model with a rich DNA - organizational genetic code to effectively deal with complexity from the outside and from the inside of the organization.

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About the Authors

Michael Frahm

Baden-Württemberg, Germany

Michael Frahm studied civil engineering and business law in Stuttgart, Kaiserslautern and Saarbrücken. Management courses at HEC Paris, HHL and Northwestern University. Winner of the Young PM Award of the GPM (IPMA) in 2010. Certification as Senior PM of the IAPM and certification as Advanced System Thinking Practitioner of the SCiO. Author of construction project management books with a systems perspective. Numerous articles and lectures on engineering and management. Lecturer on major project management and systems practice. More than 15 years of experience in the construction industry. Director of SCiO in German-speaking countries. Vice President of the EFBK- European Forum for Construction Cybernetics. He can be contacted at michael.frahm@systemspractice.org or Orcid: https://orcid.org/0000-0001-8470-6147 or Linkedin: https://www.linkedin.com/in/michael-frahm-65220573/

Dr. Martin Pfiffner

Pfäffikon, Switzerland

Martin Pfiffner lives in Pfäffikon (ZH). He is married and has a daughter. In the 1990s, he studied economics at the University of St. Gallen (HSG) and earned his doctorate. At the time, he served as an assistant to professors Peter Gross (sociology, multi-option society) and Fredmund Malik (systems-oriented management theory). Later he studied in Canada and in Wales with Professor Stafford Beer, the pioneer of management-cybernetics.

Pfiffner is one of the world's leading experts on the practical implementation of the Viable System Model and Syntegration. Over the last thirty years, he has advised numerous economic, public, and private entities across the world, helping them get back on track and achieve success. His work centers on "The third dimension of organization," which he defines as the neurology of an organization. His most recent book is The Neurology of Business: Implementing the Viable System Model (2022). Pfiffner argues that this neurology, rather than organization charts or business processes, determines whether a company is viable.

Until recently, Pfiffner managed Team Syntegrity Europe AG. He was head of the innovation group "Management Cybernetics & Bionics Division" at the Management Center St. Gallen and also responsible for developing management bionics. He is a founding member and curator of the International Bionic Center IBZ in Munich. He also initiated the Cwarel-Isaf-Conferences for management cyberneticists from all over the world.

For many years, he lectured at the University of St.Gallen (HSG), sharing his knowledge of applied management cybernetics. Between 2011 and 2016, he served on the board of the Swiss Society for Organization and Management. He is a Fellow of the Cybernetic Society England (CybSoc), a member of the International Society for System Sciences (ISSS), and an active member of Metaphorum, a society dedicated to studying the life and work of Stafford Beer. In 2017, together with several friends, he launched the Fondation Oroborus to promote management cybernetics.

Dr. Pfiffner can be contacted at m.pfiffner@fondation-oroborus.ch or on LinkedIn at: https://www.linkedin.com/in/martin-dr-pfiffner-07534459/