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Modelling the Performance of Multi-Stakeholder Public Policy: The Case of a Development Program in Morocco

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Abstract. Our main contribution, made in the context of a public administration in Morocco charged with implementing a development program mobilizing a multi-stakeholder participatory approach, is to develop a causal loop diagram (CLD) to reflect the process of creating results in the context of multi-stakeholder interrelationships. This work takes place in the context of the international community's efforts to achieve development goals through innovative mechanisms for implementing programmed interventions. In this sense, multi-stakeholder processes integrating the participatory approach are considered a collaborative and interactive mechanism to promote the sustainable management of development policies. This form of action mobilizes a growing number of public, private, international, national and local actors. Far from being isolated, these actors are linked by interdependent relationships and are part of a complex system of interactions where information, ideas, claims, know-how and relationships are exchanged in multiple directions in order to contribute to the implementation of planned projects/programs. Indeed, the structures responsible for implementing development programs are under particular pressure due to the complexity of their scope of intervention. It is essential that development practitioners have the tools to understand the dynamics of these systems and the key drivers of their behaviour, enabling them to identify leverage points for effective action. System dynamics tools are well suited to meet this challenge.

The model developed in this paper explicitly links the implementation actions taken by actors to outcomes by integrating the different steps in the results chain, as well as planning, implementation and monitoring activities. This model reflects the behaviour of the system as a result of the actions and reactions of all the actors involved at each level of implementation of the program studied, thus making it possible to understand the relationships of influence between the actions undertaken and the results obtained through the behaviour generated by the system. Developing dynamic hypotheses in relation to the real behaviour of the system allows the analysis of the dynamics and behavioural factors of the system, favouring the development of a performance improvement framework based on the elaboration of action scenarios taking into account the logic of influence between all the components of the system.

Keywords: Modelling; public performance; development program; complex system; system dynamics

1. Introduction

Multi-stakeholder processes have played a crucial role in the implementation of sustainable development-related goals since the 2002 Johannesburg World Summit on Sustainable Development (Pattberg and Widerberg, 2016). The “partnership” approach to integrated management has also been promoted worldwide as a promising way to address development policy management challenges and decisions (Momen, 2020; Warner, 2006). In this sense, the notion of multi-stakeholder participation has been strongly promoted by development actors worldwide as a response to the growing demand for participatory governance, stakeholder engagement and interactive implementation of development interventions (Hajer et al., 2015; Pahl-Wostl, 2007; Peter and Swilling, 2014). Thus, multi-stakeholder processes incorporating the participatory approach are seen as collaborative and interactive mechanisms to manage change, enhance community capacity and promote sustainable management of development policies (Brouwer et al., 2015; Mutahara et al., 2020). Tukker and Butter (2007) state that a multi-stakeholder participatory process fosters the emergence of a pathway of positive transitions in a multi-dimensional system through interactions among stakeholders and their constituencies. Similarly, Pekkarinen and Harmaakorpi (2006) addressed the role of interactions and collaborations in the improvement and generation of new knowledge in multi-stakeholder innovation networks. Thus, sustaining collective action by promoting inclusive spaces for interaction among stakeholders across multiple scales and sectors is one of the key challenges in governance, which is required for the implementation of development policies at the international, national, regional and local levels to meet the aspirations of the development goals.

While cooperation among a variety of members can contribute to the advancement of adaptive best practices, it can also lead to unanticipated reactions, as the actions taken by a single actor may not be truly aligned with the perspectives, assumptions or expected outcomes of others, leading to unexpected reactions (Brugnach and Ingram, 2012; Pluchinotta et al., 2018). This can cause the system to generate behaviours that push to neutralize the interventions being conducted by defeating them as a form of dynamic dysfunction (Sterman, 2000).

One of the fundamental challenges of conducting such an exercise is operating in a very complex context. It is a system with a multitude of parameters and actors in constant interaction (Chatibi and Lotfi, 2018). The result of this complexity is that, very often, there is no obvious linear causality to attribute a change to the action of an actor. Observed changes almost always have multiple causes, and acting on one variable can have uncontrolled effects on others.

In such a context, the ambiguous and unpredictable nature of the domain of intervention, the importance of non-linear interactions in organizational dynamics and the functions of emergence, co-evolution and self-organization must be emphasized (McDaniel and Driebe, 2001). Therefore, it is necessary to understand the complex causalities and multiple links that characterize such a system. This often involves trying to identify the most influential parameters of the system in order to act as early as possible. The use of the analytical approach in such contexts is gradually being challenged and complemented by a new form of approach called the systems approach.

The systems approach considers a problem in all its dimensions. Its application in public administration, and specifically in the implementation of development programs, could allow for a better understanding of the complexity of the problems related to this field of intervention, of the stakes involved in development and of the need for all actors to take well-thought-out action. Managing development programs is such a vast mission that understanding the links between them makes it easier to understand this entity and to know where and how to act at our level for this development.

Considering to act in a context of apparent complexity, we need specific instruments to represent our perceptions in order to facilitate the interpretation and analysis of our field of intervention. To do so, we model the system on which we intervene with a systemic and multi-level approach.

In this sense, the use of system dynamics modelling allows us to develop a representation that highlights the structure and behaviour of the system studied. In complex systems, individuals have to develop a common vision of the situation within the organization, as well as its implications and meaning, in order to overcome the lack of understanding of the dynamics of this type of system.

Through the work presented in this paper, we are interested in constituting the basis for guiding the envisaged performance improvement work. Consequently, we conducted an analysis of the existing work based on modelling. This exercise aimed, on the one hand, to understand the functioning of each component of the National Initiative for Human Development (NIHD) program and to identify the existing interactions between the different actors. On the other hand, this work sought, through the participation of all stakeholders in its realization, to start a relationship of trust and communication with and between the various stakeholders to facilitate the ownership of the results from a perspective of change management. Through our contribution, we intend to support the managing entity in the choice of measures to be put in place to improve the performance of the program for which it is responsible. The choice of modelling makes sense because of the complex nature of our field of intervention.

We divided this paper into three principal parts. The first part specifies the positioning of the research in the theoretical field and highlights the needs concerning the modelling and the specificities to be considered in the envisaged performance improvement work. We then present the methodological framework that served as a reference for the realization of our causal loop diagram (CLD) by detailing the research approach that we used and the methods we used to develop our models. Then, we present, in the third part, the results from the modelling and the analysis.

2. Literature Review

2.1. Multi-stakeholder complexity

The multi-stakeholder public policy can be viewed as a complex system, and using Stevenson's (2012) sens complexity is an underlying feature of human social systems. According to Franco (2002), social organizations exist to achieve a specific goal, and such systems contain and transmit concepts, values, ideas and culture that influence the system's dynamics. According to Duek et al. (2010), social systems are characterized by intentional agents who make decisions about their own and others' purposes. These individuals, on the other hand, are autonomous, heterogeneous individuals who are purposeful in nature and strive to achieve their own goals (Bogg and Geyer, 2007).

Social complexity frequently takes the form of wicked problems, in which stakeholders are unable to explicitly identify the problem and have no real framework for determining success or getting any simple solutions on hand (Barry and Fourie, 2001; Proches and Bodhanya, 2013). This complexity persists because each agent has a different perspective on the world, and no one perspective is correct or incorrect (Proches and Bodhanya, 2013). This reflects each actor's mental models, which capture their perspectives on how they see reality. The behaviour of agents is generated by their relational model, which results in an action based on their perception of the environment (Anderson, 1999).

The dynamic interactions of stakeholders who are engaged in performing a specific goal give rise to social complexity. Thus, organizations can no longer be understood in a mechanistic manner in which assumptions and solutions about the whole are based on an examination of the individual parts (Stevenson, 2012). The concept of a rational agent is also called into question due to its failure to account for the complexity that arises from dynamic systems containing various actors (Levy, 2000). According to the same author, the field of management can benefit from the complexity theory by understanding how effective learning and self-organization can result in the emergence of new forms.

Over the past 50 years, system dynamics has evolved in tandem with sustainability research (Pedercini et al., 2020), beginning in the early 1970s with Jay Forrester's seminal book, *The Limits to Growth*, which studied global dynamics and predicted the failure of the socio-technological-natural system by the middle of the 21st century. Since then, collaboration between system dynamics and sustainability research has advanced in many areas, including the environment and energy (Ford, 1997) and socio-cultural systems, all in the context of sustainability (Saeed, 2019). New theories supporting sustainability in other areas have also prompted the use of system dynamics modelling. These include the use of system dynamics for resilient governance in the face of extreme ambiguity (Eker and Van Daalen, 2015; Kwakkel and Pruyt, 2013), in which system dynamics models with relatively simpler and faster simulation engines allow for the exploration of many decision measures in a wide range of realistic scenarios.

2.2. System dynamics for complex systems

System dynamics is an approach developed to understanding, analysing and managing complex transdisciplinary phenomena with multiple stakeholders, interactions and feedback, such as those found in many organizations and other social systems. It is an approach that strives to design a framework using representational models to illustrate certain parameters of the reality of complex systems (Elias, 2012). System dynamics modelling provides a mature thinking framework for developing an advanced understanding of the internal structure of the system under study (Yin et al., 2013).

The system, the central object of the approach, is defined as "a complex of interacting elements" (Von Bertalanffy, 1968). The development of this definition presents the system as a dynamic interaction between its components, oriented according to a goal (Joël, 1975). In the sense given by Le Moigne (1977), a system is an object for its own purposes that carries out an activity in a specific environment and that has an internal structure that develops over time while preserving its identity.

The multiplicity of the elements that make up a system and the multiplicity of their interactions, to which the diversity of its dynamic behaviours is added, represent the sources of its complexity. Considering this characteristic of the interdependence of the elements of a system, trying to conduct a separate analysis of a system is almost utopian (Baubeau and Pereira, 2004).

All of these characteristics can only show the difficulty of dealing with complex systems in the sense that the global and local in such areas are intimately linked. Any intervention that is considered must be related to the global behaviour of the system as well as to the specific context in which it is situated (Keating et al., 2001). The actions are thus intertwined in a complex context and involve several scientific disciplines and multiple stakeholders (Beers et al., 2006).

To complete our analysis of the existing situation, we resorted to the dynamic modelling of systems through the causal loop diagram tool to have a visualization of the dependency relationship between the components of our system. We argue that CLD is a particularly useful method for our study, as it is widely applied in situations where interacting processes and effects are nonlinear (Davis et al., 2007).

In this sense, the causal loop diagram is often used to show the causal relationships between several interacting variables (Morecroft and Sterman, 1995) through a qualitative model that maps the elements/variables of the system and shows the causal relationships that are formed between them. In addition, it is a simple way to clearly observe feedback loops that can result in complex behaviours (Myrovali et al., 2018). The arrow connecting one variable to another symbolizes a causal relationship in the Forrester diagrams, where the signs on the arcs correspond to the polarity of the causal relationship. Thus, a positive notation (+) shows that the more we do the action at the origin of the arrow, the greater the effect at the tip of the arrow, showing that the variables move in the same direction. On the other hand, a negative notation (−) shows that the more we do something, the less effect it has. Here, the variables move in opposite directions.

These relationships represent the basis for the constitution of feedback loops in a CLD, which are of two kinds: positive and negative. Positive feedback loops are those where the variation of an element propagates throughout the loop so that the initial variation is reinforced, hence the name amplifying loops (Quan-chen et al 2016). Popular names for this type of loop are the snowball and vicious circle effects. This type of loop has either explosive (exponential growth) or implosive (faster and faster decay) behaviour. Feedback is positive if it contains an even number of negative relationships or only positive relationships (Cambien, 2008). Negative feedback loops oppose and respond to change and describe processes that tend to generate equilibrium. The specificity of these loops lies in the self-correcting behaviour of the generated actions. In other words, any variation produced on one element of the loop tends to cancel itself out. Such a loop tends to bring the structure of the system into a state of equilibrium, hence the name stabilizing loops (Myrovali et al., 2018).

3. Research Model

3.1. The case study

Our intervention takes place within the program of the (NIHD) in Morocco. This initiative, launched in 2005, represents multi-sectoral and multidimensional for development vision, based on a multi-stakeholders participative approach to improving the living conditions of disadvantaged populations. Coordination of the implementation of this initiative at the territorial level is granted to the prefecture of each locality (public administration).

Among the programs of this initiative, our study focuses on the analysis of the program of support for economic integration and improvement of the income of young people in vulnerable situations. This program is dedicated to the financing of income-generating projects (micro-projects) for the benefit of people organized in associations, cooperatives or partnerships. The amount of funding granted is approximately $21,000 per project, which represents a nonrepayable grant by the beneficiaries (free funds). The amount of the grant awarded represents 70% of the total amount of the project funding, and the remaining 30% represents the amount of the project holder's contribution.

The annual budget allocated to this program is equivalent to $620,000, which is dedicated to financing projects proposed through periodic calls for proposals.

The performance of this program is evaluated on the basis of two main financial indicators that the managing entity is expected to achieve annually. The first indicator is the commitment rate, which should reach 90% of the allocated funds; the second indicator is the emission rate, which should reach 70% of the committed amount.

For several years, the managing entity has continued to record rates below the objective (annual commitment rate of 60%; annual emission rate of 40%) despite the efforts made to improve them. In addition to these unsatisfactory rates, a significant number of projects have been cancelled or are pending, which represents a lack of optimization in the use of public funds.

It is in this context that our participation in this entity is situated. We joined the team in charge of the implementation of the program presented above to form a group of analysts to develop a CLD, allowing first to understand the behaviour of the system studied and then to constitute a basis to guide the actions of improvement of the above-mentioned indicators.

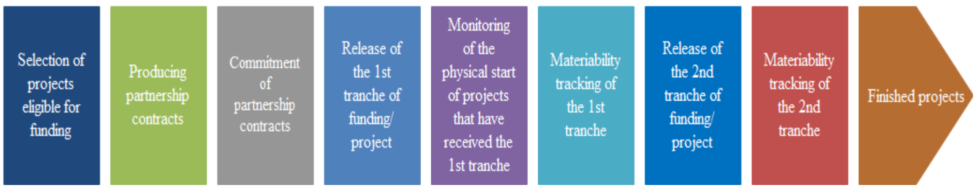
Causal loop model building process

The approach adopted in this paper is a multistep participatory methodology designed and applied to satisfy our previously stated research objectives.

The process of developing our model can be divided into two main phases. The first step aimed at clarifying the implementation phases of this program by identifying the main components of the results chain, its inputs, outputs and the actors involved in each phase. Based on these results, we began the modelling work that led to the development of our CLD.

Phase 1: Data collection and understanding of the structure of the program under study

This phase was initiated by reading and analysing the internal documents of the program under study (procedure manual, fiduciary manual, orientation note, minutes of the selection committee, minutes of the steering committee, minutes of the



monitoring committee, the reporting table, etc.), supplemented by working sessions and exchanges with officials of the Social Action Division (the division in charge of coordinating the implementation of the program at the prefecture level). The work carried out at this stage enabled us to identify the main steps in the results chain of the program studied (Figure 1), seeking to understand the general implementation process of this program and identifying the actors involved at each stage.

Fig. 1: The value chain of the income improvement program for vulnerable youth

Subsequently, we began a new series of working sessions with the participation of all the actors identified in the results chain analysis phase.

The first working session was dedicated to the presentation of the object and purpose of the exercise, as well as a presentation of the basic principles of CLD. Afterwards, the participants were invited to present their missions and roles in the implementation of the program. The participants discussed the logic of implementing the activities assigned to them, as well as the constraints and dysfunctions they observed during the execution of their functions.

Through the exchange carried out during this session, each actor was able to express his individual perceptions and expose his mental model to the other participants. At the end of this session, all participants became aware of the elements constituting the result chain, thus moving from a partial view of the implementation process of the program in question to a global view of the general structure of the program studied.

Based on the results of this phase, we were able to identify the main components of each step of the youth income-generation program's results chain, as detailed in Table 1 below.

Table 1: The value chain components of the income enhancement program for vulnerable youth

Phase	Actors involved	Activity to be carried out	Result of the phase
Selection of projects eligible for funding	Members of the technical commission	Evaluate the quality of the submitted projects Assign the score for each project	Final list of projects eligible for funding
	Members of the piloting committee	Awarding the final decision of acceptance or rejection Deciding on the list of projects eligible for funding	

Producing partnership contracts	Project holder	Certify the payment of the participation to the project (30% of the amount of the project)	Partnership contracts validated for commitment
	Program manager	Elaborate partnership contracts for the financing of accepted projects	
	The president of the piloting committee	Validate partnership contracts	
Commitment of partnership contracts	Manager of the budget service	Validate the programming of budgets allocated to each project in the budget management system	Committed contracts
Release of the 1st tranche of funding/proje ct	Manager of the budget service	Validate the release of the 1st tranche of the project's financing amount	The 1st tranches paid to the accounts of the project holders
Monitoring of the physical start of projects that have received the 1st tranche	Project holder	Justify the physical start of the project	Lite of the started projects
	Monitoring committee	Validate the physical start of the project	
	Program manager	Establish the validation minutes for the launch of projects	
Materiability tracking of the 1st tranche	Project holder	Justify the materiality of the expenses incurred in the execution of the 1st tranche	List of projects that have completed the 1st phase
	Monitoring committee	Validate the materiality of the execution of the 1st tranche	
	Program manager	Etablir les PV de validation de la matérialité de la 1ère tranche	
Release of the 2nd tranche of funding/proje ct	Manager of the budget service	Establish the validation minutes of the materiality of the 1st tranche	The 2nd tranches paid to the accounts of the project holders
Materiability tracking of the 2nd tranche	Project holder	Justify the materiality of the expenses incurred in the context of the execution of the 2nd tranche	List of projects that have completed the 2nd phase
	Monitoring committee	Validate the materiality of the execution of the 2nd tranche	
	Program manager	Validate the materiality of the execution of the 1st tranche	

Source: Authors' analysis

The interpretation of this table illustrates the multi-stakeholder intervention mode at the level of each phase, with an interrelated execution of the activities allowing the achievement of a particular result.

This phase was knowledge-structuring and constituted clarification of the general structure of the system under investigation to guide the development work of our CLD (moving from structure to behaviour).

Phase 2: Design and analysis of the causal loop diagram

The development of our causal loop diagram was based on the results of the outcome chain analysis phase. Following this phase, we organized a series of work sessions. Each session brought together the actors involved in each step of the results chain. The objective of the session was to identify the variables that would allow for the development of intermediate causal loops (causal loops for each step in the results chain).

The loop was constructed according to the logic "From structure to behaviour" by exploiting the elements of Table 1. Thus, for each loop, we started by identifying its triggering element, which represents the result of the previous step in the result chain, and then deduced the effect it generated to define the first variable of our loop.

For example, the trigger for the first loop was the notification of funds (amount allocated to the program), which informed us of the number of projects likely to be funded. This information allowed us to deduce the 1st variable of the loop named "Number of desired projects". The number of desired projects reflects the available funding capacity, which, in turn, translates into a willingness to fund new projects. This is expressed by the 2nd variable of our loop named "No. of accepted projects". The information from this 2nd variable corresponds to the result of the 1st step of the result chain (list of projects accepted for funding) presented in Table 1. The result of this step represents the trigger for the second loop and so on.

Each session allowed us to develop a causal loop explaining the mental model of the actors in the stage analysed using the free software VENSIM 8.2.0.

Once the working sessions per stage were completed, a final session was organized with all stakeholders from all stages. The causal loops developed for each step were used as a basis for guiding the collaborative discussion from a partial view (individual loops) to an overall view (collective loops grouping all the individual loops) and for refining the causal links between the loops to develop the CLD model presented in Figure 2. This work allowed us to guide the stakeholders in developing a consensus on their perceptions of the system under investigation through participatory exercises.

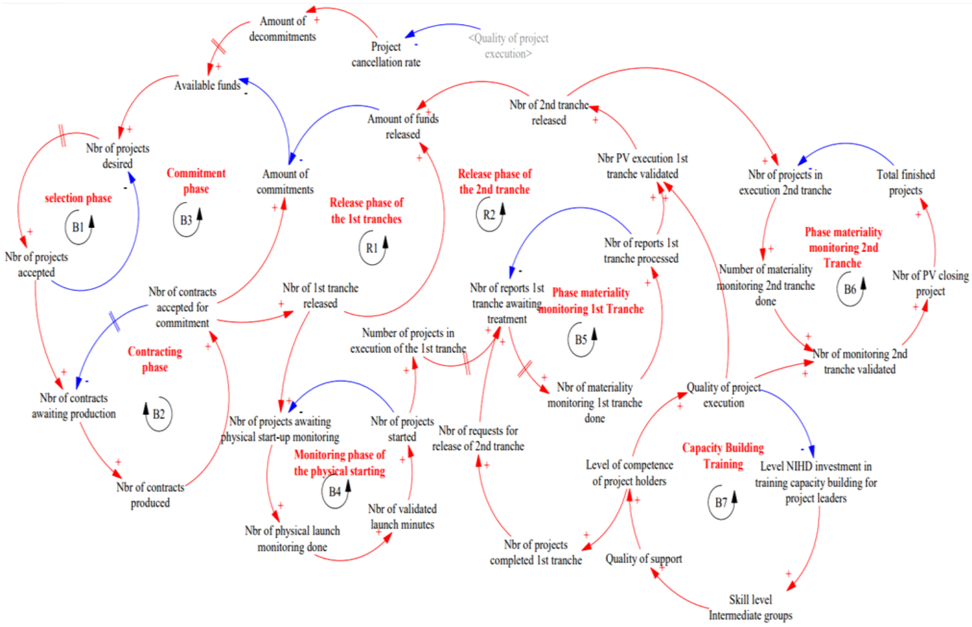


Fig. 2: Causal loop diagram of the income enhancement program for vulnerable youth

This diagram is an intermediate form of representation of our empirical knowledge, allowing us to conduct qualitative analyses of the behaviours of the NIHD system to guide us in formulating the basic elements for the definition of measures that could improve the performance of NIHD interventions in the target prefecture.

The 1st loop represents the selection phase. The main actor in this loop is the technical commission, which is responsible for processing the applications and awarding the evaluation based on the quality of the application. The list of projects accepted for funding is decided by the piloting committee on the basis of the results of the technical commission. This loop, through the effect of the quality of the selected projects, has an immediate effect on the contractualization loop and the commitment loop and a delayed effect on the quality of the execution of the projects, thus influencing the rate of issuance and the rate of completed projects.

The analysis of this loop revealed that some project holders abandon the funding process after having obtained the acceptance of the commission, which interrupts the equilibrium of this loop in the sense that not all of the accepted projects will be funded, which will generate a new need to restart the selection process to reach the level of desired projects. It expresses an unexpected action of the project leaders that influences the behaviour of the system.

The loop will maintain its equilibrium by neutralizing the effect of the abundance rate, which should be maintained at almost zero by improving the selection process in conjunction with a multi-criteria evaluation process.

However, the quality of selection is not only influenced by the quality of the project application but also by the level of experience and competence of the members of the technical committee in assessing the quality of project design. Therefore, particular importance should be given to the process and the basic criteria for the selection of panel members.

The 2nd loop represents the contracting phase. The analysis of this loop revealed a significant influence of the time it takes to process contracts on the commitment rate. We found that the rate of production of contracts increases towards the end of the year and, therefore, towards the closing date of the commitments. Faced with this situation, the staff is obliged to increase the production rate to the detriment of the time allocated to drafting, which accentuates the rate of error generation and thus reduces the number of agreements accepted for commitment.

Establish a schedule for editing contracts in such a way as to allow the necessary time for quality editing and thus increase the rate of contracts accepted for commitment.

The third loop refers to the commitment phase that is directly influenced by the quality of the contracts processed and, therefore, the acceptance rate for commitment. The more agreements that are committed, the more funds are available and, therefore, the fewer projects that need to be funded.

The improvement of the first two loops will directly influence the level of commitment and, therefore, the achievement of the desired objective.

The 4th, 5th and 6th loops illustrate the monitoring processes that influence the rate of emission of funds. The 5th and 6th loops are strongly influenced by the quality of project implementation, which, in turn, is dependent on the quality of the project at selection and thus the selection process (Loop 1).

Another important factor influencing the rate of project implementation is the level of competence of intermediary groups and project holders (Loop 7), which plays an important role in the process of project implementation through the quality of the support provided to project managers.

4. Discussion

The developed CLD allowed all the actors to understand the behaviour of the analysed system through the establishment of influential relationships between the different components of the result chain and implicitly between the different actors involved. Thus, they moved from an action logic based on the structure that represents the static view of their system to an action logic based on the general behaviour of the system, which illustrates the dynamic view.

Thanks to this model, all the actors were able to visualize the sequence of all the phases of implementation of the interventions initiated within the framework of the analysed program as well as the existing interactions, thus facilitating the interpretation and the identification of the sources of the recorded lack of performance.

The main source identified was related to the way in which the limitations of the NIHD system were considered, which influenced the dimensions considered for defining the measures taken to improve the performance indicators.

This exercise simplified all participants' understanding of the behavioural reality of the NIHD system. Indeed, the implementation of the analysed program is based on a multi-stakeholder approach (multi-sectoral representatives in the selection committee, the monitoring committee and the steering committee) and a participatory approach (deliberate decision-making between actors representing the associative fabric, the deconcentrated sectors of the state and the local authority).

However, our analysis revealed that actual implementation is concentrated at the internal level (the managing administration, which represents the physical limit of the system). This way of looking at the NIHD system puts particular pressure on internal managers at the prefecture level, for whom the problem of improving target performance indicators can be achieved through the adoption of good management practices through strong internal coordination.

The modelling exercise we conducted allowed us to initiate a reflection on this topic and to initiate an awareness to rethink that the limit of the NIHD system is beyond the real limit of the prefecture's physical system. Indeed, the real limit of the NIHD system should also include all actors involved in the chain of results. This way of thinking about the NIHD system has fostered a new way of looking at the program's indicator improvement exercise, which should be carried out in a coordinated manner throughout the system's implementation process according to a multidimensional logic and not just at the level of a single loop or be limited to internal management.

To structure the presentation and explanation of our model according to multi-dimensional logic, we grouped our factors into three broad categories that influence each other:

- The first category corresponds to factors of a human nature, such as productivity, stress, level of competence and expertise and inter-actor communication;

- The second category corresponds to factors of an organizational nature, such as planning, task allocation, control of project execution and satisfaction of objectives;

- The third category includes variables related to the external environment, such as the involvement of partners, compliance with commitments, etc.

The current study is the first of its kind in our field of study to use modelling languages and, more particularly, dynamic modelling through the CLD to analyse the NIHD system.

The process adopted for the development of our model is based on a participatory approach to promote the development of a collective reflection through an effective participation of stakeholders for the treatment of the problem in question in the sense that the improvement of target rates must be done by a synchronized action and a collective coordination of all actors involved.

However, for the realization of this research, we should face certain constraints already raised at the level of literature specialized in the dynamics of the systems.

The first constraint was the lack of an explicit framework of steps to follow for the development of our CLD. The literature presents only the main steps of the modelling process, limiting itself to brief descriptions of the modelling process without providing a complete guide for its deployment (Forrester, 1958; Forrester, 1994; Maani and Cavana, 2007; Richardson and Pugh, 1981; Sterman, 2002; Vennix et al., 1992), which may be satisfactory for academic purposes and for theory building (Schwaninger and Hamann, 2005) but presents a major constraint when interacting with the practical world and particularly in the presence of actors new to modelling.

To address this shortcoming, some researchers have moved toward adopting combined methods approaches to guide their modelling work to represent mental models in order to facilitate the construction of dynamic models (Hall et al., 1994; Lane, 1992; Vennix et al., 1992; Vennix, 1996).

It is in the continuity of this movement that our research takes place. Thus, we adopted a two-step method to convey the development of the causal loop diagram using a combined modelling approach following the logic of structure-based dynamics. To this end, we began our CLD development exercise with an analysis of the structure of the program under study, which resulted in the construction of the result chain presented in Figure 1 and, subsequently, an analysis of the components of each stage of the result chain summarized in Table 1.

The main reason for conducting this exercise was to facilitate a smooth transition to the development of the CLD model in a way that ensured that the actors involved in this exercise had fully understood the difference between a system component that reflects its structure and, therefore, its static state and the behaviour that expresses its dynamics.

This approach was mainly motivated by the presence of actors with different levels of education and different interests, as well as by the fact that they were new to modelling. This situation led us to move progressively from structure to behaviour in order to generate a common understanding close to the reality of the system under analysis.

Another challenge that we should face in the implementation of this approach is to overcome the traditional development logic of system dynamics models that are carried out according to an external consultant logic, in which a modelling expert studies a problem, develops the dynamic model, analyses it and formulates recommendations for the resolution of the investigated problem. The results of the implementation of this type of approach are rather limited in the sense that the collective perception and vocabulary of the actors of the real system and that of the external consultant do not coincide, leading to a rejection of the appropriation of the designed model (Zock and Rautenberg, 2004). To overcome this obstacle in our field of study, we adopted a participatory approach for the development of the models designed in this research by inviting all the actors involved in the global process of implementation of the program studied to take part in all the phases of the modelling project, either at the structural or dynamic level.

The use of the logic of collective construction of the explanatory model of the analysed system allowed, through consideration of the cognitive dimension, to move from an action based on a partial perception of the actor to the development of an overall view by integrating the different perceptions of the actors working in our system. Moreover, by following a pluralistic and global approach, we have worked towards the conception of a conceptual framework accepted by all on which the rest of this research is based at the dynamic level.

5. Conclusion

The initial intention to understand the implementation system of the program studied in order to propose a basis for formulating an approach to improve the performance of development programs based on a multi-stakeholder approach led us to adopt a systemic approach using dynamic system modelling. The results obtained allowed us to achieve our objectives. Thus, we were able to clearly visualize the functioning of our system and facilitate an understanding of the dependency relationships between its elements.

Moreover, by adopting a systemic approach, our work favoured dialogue and exchange with people from different backgrounds and functions using different languages. This multidisciplinary character allowed us to enrich and adapt our research work and bring new knowledge corresponding to the expectations of all stakeholders.

Through our experimentation, we have confirmed that the application of a systemic approach to the study of our development program highlights the mechanisms of its implementation and the relationships of dependence between its elements, thus improving the understanding of our field of intervention.

We can show this through our models by the existence of dependency relationships between several dimensions that influence each other. This has led us to think about a way of acting that allows us to put in place the conditions that favour the emergence of the desired performance by working on all the factors while respecting this multi-actor dependency relationship.

In fact, this study demonstrated the usefulness of using causal loop diagrams to visualize the interdependence and mutual influence of the actions carried out by the main stakeholders and to show how this influences the targeted performance indicators. This work has also fostered the emergence of a basis for communication and exchange that allows for a structured and focused discussion among stakeholders to develop an integrated perspective on the complex issues of managing the program in question.

However, dynamic behaviour cannot be deduced from qualitative modelling alone (Richardson, 1996), which is the main limitation of our work. To overcome this constraint, we plan to start a second phase of our research (which will be the subject of another article) for the development of the quantitative model (stock-flow diagram), favouring the consideration of the temporal dimension for the development and testing of improvement scenarios through a simulation exercise.

References

Anderson, P. (1999). Perspective : Complexity theory and organization science. Organization science, 10(3), 216-232.

Barry, M., & Fourie, C. (2002). Wicked problems, soft systems and cadastral systems in periods of uncertainty : South African experience. Survey review, 36(285), 483-496.

Baubeau, D., & Pereira, C. (2004). Mesure de la performance dans le domaine de la santé. Dossiers solidarité et santé, 3, 47-56.

Beers, P. J., Boshuizen, H. P., Kirschner, P. A., & Gijselaers, W. H. (2006). Common ground, complex problems and decision making. Group decision and negotiation, 15(6), 529-556.

Bertalanffy, L. von. (1968). General system theory : Foundations, Development, Applications (J.-B. Chabrol, Trad.; George Braziller).

Bogg, J., & Geyer, R. (2007). Complexity, science and society. Radcliffe Abingdon.

Brouwer, H., Woodhill, J., Hemmati, M., Verhoosel, K., & van Vugt, S. (2019). The MSP guide : How to design and facilitate multi-stakeholder partnerships. Practical Action Publishing.

Brugnach, M., & Ingram, H. (2012). Ambiguity : The challenge of knowing and deciding together. Environmental science & policy, 15(1), 60-71.

Cambien, A. (2008). Une introduction à l'approche systémique : Appréhender la complexité (Rapports d'étude du Certu) [Rapport de recherche]. Centre d'études sur les réseaux, les transports, l'urbanisme et les ….

Chatibi, Z., Lotfi, B., & Semma, E. A. (2018). Le tableau de bord prospectif pour la mesure de la performance des programmes de développement : Cas des programmes INDH au Maroc. Colloque international ISEOR 2018, Lyon, France.

Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. (2007). Developing theory through simulation methods. Academy of Management Review, 32(2), 480-499.

Duek, A., Brodjonegoro, B., & Rusli, R. (2010). Reinterpreting Social Processes : How System Theory Can Help To Understand Organizations And The Example Of Indonesia's Decentralization. Emergence: Complexity & Organization, 12(4).

Eker, S., & Van Daalen, E. (2015). A model-based analysis of biomethane production in the Netherlands and the effectiveness of the subsidization policy under uncertainty. Energy Policy, 82, 178-196.

Elias, A. A. (2012). A system dynamics model for stakeholder analysis in environmental conflicts. Journal of Environmental Planning and Management, 55(3), 387-406.

Ford, A. (1997). System dynamics and the electric power industry. System Dynamics Review: The Journal of the System Dynamics Society, 13(1), 57-85.

Forrester, J. W. (1958). Industrial Dynamics : A Major Breakthrough for Decision Makers. Harvard Business Review, 37-66.

Forrester, J. W. (1994). System dynamics, systems thinking, and soft OR. System dynamics review, 10(2-3), 245-256.

Franco Parellada, R. J. (2002). Modeling of social organizations : Necessity and possibility. Emergence, 4(1-2), 131-146.

Hajer, M., Nilsson, M., Raworth, K., Bakker, P., Berkhout, F., De Boer, Y., Rockström, J., Ludwig, K., & Kok, M. (2015). Beyond cockpit-ism : Four insights to enhance the transformative potential of the sustainable development goals. Sustainability, 7(2), 1651-1660.

Hall, R. I., Aitchison, P. W., & Kocay, W. L. (1994). Causal policy maps of managers : Formal methods for elicitation and analysis. System Dynamics Review, 10(4), 337-360.

Joël, D. R. (1975). Le macroscope, vers une vision globale. Seuil." Points Essais, 80, 346.

John D. W. Morecroft, & Sterman, J. D. (1995). Modeling for Learning Organizations. The Journal of the Operational Research Society, 46(6), 793-795. JSTOR. https://doi.org/10.2307/2584318

Keating, C. B., Kauffmann, P., & Dryer, D. (2001). A framework for systemic analysis of complex issues. Journal of Management Development.

Kwakkel, J. H., & Pruyt, E. (2013). Exploratory Modeling and Analysis, an approach for model-based foresight under deep uncertainty. Technological Forecasting and Social Change, 80(3), 419-431.

Lane, D. C. (1994). Modelling as Learning : A Consultancy Methodology for Enhancing Learning in Management Teams. Modelling for Learning Organizations. JDW Morecroft and JD Sterman. Portland, OR. Productivity Press.

Le Moigne, J.-L. (1977). La théorie du système général : Théorie de la modélisation (1ère Ed). PRESSES UNIVERSITAIRES DE FRANCE.

Levy, D. L. (2000). Applications and Limitations of Complexity Theory in Organization. Handbook of strategic management, 67.

Maani, K. E., & Cavana, R. Y. (2007). Systems thinking, system dynamics : Managing change and complexity. Pearson Prentice Hall.

McDaniel, R. R., & Driebe, D. J. (2001). Complexity science and health care management. In Advances in Health Care Management (Vol. 2, p. 11-36). Emerald Group Publishing Limited. https://doi.org/10.1016/S1474-8231(01)02021-3

Momen, M. N. (2020). Multi-stakeholder partnerships in public policy. Partnerships for the goals. Encyclopedia of the UN sustainable development goals, 1-9.

Mutahara, M., Warner, J. F., & Khan, M. S. A. (2020). Multi-stakeholder participation for sustainable delta management : A challenge of the socio-technical transformation in the management practices in Bangladesh. International Journal of Sustainable Development & World Ecology, 27(7), 611-624.

Myrovali, G., Tsaples, G., Morfoulaki, M., Aifadopoulou, G., & Papathanasiou, J. (2018). An interactive learning environment based on system dynamics methodology for sustainable mobility challenges communication & citizens' engagement. The proceedings of the 4th International Conference on Decision Support Systems, ICDSST 2018, 88-99. https://doi.org/10.1007/978-3-319-90315-6

Pahl-Wostl, C. (2007). The implications of complexity for integrated resources management. Environmental Modelling & Software, 22(5), 561-569.

Pattberg, P., & Widerberg, O. (2016). Transnational multistakeholder partnerships for sustainable development : Conditions for success. Ambio, 45(1), 42-51.

Pedercini, M., Arquitt, S., & Chan, D. (2020). Integrated simulation for the 2030 agenda. System Dynamics Review, 36(3), 333-357.

Pekkarinen, S., & Harmaakorpi, V. (2006). Building regional innovation networks : The definition of an age business core process in a regional innovation system. Regional Studies, 40(4), 401-413.

Peter, C., & Swilling, M. (2014). Linking complexity and sustainability theories : Implications for modeling sustainability transitions. Sustainability, 6(3), 1594-1622.

Pluchinotta, I., Pagano, A., Giordano, R., & Tsoukiàs, A. (2018). A system dynamics model for supporting decision-makers in irrigation water management. Journal of environmental management, 223, 815-824.

Proches, C. N. G., & Bodhanya, S. (2013). An analysis of multi-stakeholder interactions in the sugar industry using a social complexity framework. Problems and perspectives in management, 11, Iss. 4, 77-85.

Quan-chen, D., Jian-jun, Z. and Shi-tao, Z. (2016). Method for Group Decision-Making of Multi-Stakeholders with Category Preference on Alternatives", International Journal of u - and e - Service, Science and Technology, NADIA, 9(8): 133-148, http://dx.doi.org/10.14257/ijunnesst.2016.9.8.11.

Richardson, G. P. (1996). Problems for the future of system dynamics. System Dynamics Review: The Journal of the System Dynamics Society, 12(2), 141-157.

Richardson, G. P., & Pugh III, A. L. (1997). Introduction to system dynamics modeling with DYNAMO. Journal of the Operational Research Society, 48(11), 1146-1146.

Saeed, K. (2019). Towards sustainable development : Essays on system analysis of national policy. Routledge.

Schwaninger, M., & Hamann, T. K. (2005). Theory-Building with system dynamics : Principles and practices. International Conference on Computer Aided Systems Theory, 56-62.

Sterman, J. (2002). System Dynamics : Systems thinking and modeling for a complex world.

Sterman, J. D. (2000). Business Dyanmics : Systems Thinking and Modeling for a Complex World. Irwin/McGraw-Hill.

Stevenson, B. W. (2012). Developing An Awareness And Understanding Of Self-Organization As It Relates To Organizational Development And Leadership Issues. Emergence: Complexity & Organization, 14(2).

Tukker, A., & Butter, M. (2007). Governance of sustainable transitions : About the 4 (0) ways to change the world. Journal of Cleaner Production, 15(1), 94-103.

Vennix, J. A., Andersen, D. F., Richardson, G. P., & Rohrbaugh, J. (1992). Model-building for group decision support : Issues and alternatives in knowledge elicitation. European journal of operational research, 59(1), 28-41.

Vennix, J. A. M. (1996). Group model building : Facilitating team learning using system dynamics. J. Wiley; /z-wcorg/.

Warner, J. F. (2006). More sustainable participation ? Multi-stakeholder platforms for integrated catchment management. Water resources development, 22(1), 15-35.

Yin, J., Xie, Z., & Guo, J. (2013). Study on the Real Estate Credit Risk Based on System Dynamics. Journal of System and Management Sciences, 2(4), 31-36.

Zock, A., & Rautenberg, M. (2004). A critical review of the use of system dynamics for organizational consultation projects. Proceedings of the 22nd International Conference of the System Dynamics Society, Oxford, 1-29.