Exploring the CIMO-logic in the design of collaborative networks mediated by digital platforms

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Abstract. Collaborative networks (CNs) of organizations are nowadays complex and intertwined compositions of technological, cognitive and social artifacts. The design of such compositions should be addressed as a socio-technical endeavor as a way to maximize the success probability. In despite of intensive research in this community, much has to be explored to achieve sound contributions to a design theory of CNs. In this paper, we make use of the context-intervention-mechanism-outcome logic (CIMO-logic) as a way to improve the design propositions component of a CN design theory. Variations of the concept of "mechanism" are explored with the goal of making clearer the socio-technical perspective in the design propositions. This theoretical exploration is illustrated with a case of transforming an industrial business association (IBA) in a digital collaborative network.

Keywords: collaborative networks, design theory, socio-technical systems, CIMO-logic, digital platforms

1 Introduction

Digital platforms (DPs) play a fundamental role in today's connected and data-rich society supporting information sharing, collaboration and collective action [1], in cooperation settings such as online communities or enterprise networks. In the business domain, DPs have been fundamental for organizational strategies, strongly relying on formal and informal relationships with other entities, with variations of DPs being designed and developed to improve the management of processes and activities, in particular supporting collaboration and information management [2, 3]. Notwithstanding this development, the full potential of DPs is far from being released or even acknowledged by the individual companies or business networks [4]. The reason for this lies in two interrelated challenges: on the one hand, in the intrinsic organizational and managerial complexity in implementing collaboration-based inter-organizational structures and behaviors [5] and, on the other hand, in the lack of guidance in the design and implementation of DPs as socio-technical systems [6].

Design Science Research (DSR) is a research paradigm that has been used in research for the construction of viable and innovative artifacts [7]. An artifact can take many forms. It can be a conceptual artifact, represented by a method, model or framework [8], or it can also represent design theories and design principles [9], algorithms and guidelines. The main strengths of DSR are the focus on the creation of artifacts for addressing unsolved problems in organizations [7, 8], the rigorous evaluation of these artifacts [10], and the contribution with new knowledge to the body of scientific evidence [11].

Design propositions represent another type of artifact in DSR [12]. Design propositions are used mainly in business and management studies to obtain prescriptive knowledge and design principles, helping people and organizations to solve specific field problems [13]. The CIMO-logic is a framework that was first proposed by Denyer et al. [14] to help in the development of more rigorous design propositions. The definition of these four components in each design proposition allows for a better understanding and agreement between the design team, who wants to propose some interventions to a specific problem faced by an organization, and the practitioners, who want to have their problems solved.

The current literature of CIMO shows the applicability of this prescriptive framework in different organizational and societal contexts, such as organization and management studies [14], community building in education [15], and business models for sustainability [16]. However, the research problem that is posed now is related with the current discrepancies in previous CIMO-logic studies, where we can find different interpretations or a lack of understanding about the meaning of each component of CIMO. On the one hand, the fact of existing different interpretations of the CIMO-logic is good because it allows to obtain insightful discussions among the research community and for the sake of progression of this specific framework. On the other hand, the vastness of versions for the CIMO-logic that we can find in the literature also causes additional difficulties for both current and new researchers that want to use this framework in their research projects, creating problems as well for obtaining a more agreed and unified version.

It is not the aim of this paper to provide this unified version for the meaning of each component that integrates the CIMO-logic. The paper's goal is to instead present and discuss different interpretations and versions of the application of CIMO in various research contexts, which may contribute to a further detailed extension of this research in a different study. To achieve that, we first analyze the current CIMO literature and present some particular applications. After that, we use our own data from a previous research project to present a case study with two different interpretations/versions for the application of this prescriptive framework, having as a context, the design of CNs mediated by DPs.

With this paper we hope to provide a perceptive discussion about the CIMO-logic, helping to clarify the components that make up this prescriptive framework. Another contribution of this paper is to show the importance of using the CIMO-logic to obtain more rigorous design propositions, as innovative DSR artifacts. We also expect that the findings of this paper can support researchers to co-design more effective CNs, socio-technical systems, and cognitive systems, by using the CIMO-logic.

2 CIMO-logic

2.1 Design propositions and the CIMO-logic components

Denyer et al. [14] present an extension of the so-called CIMO-logic as a discussion of prescriptive knowledge in the form of design propositions. The CIMO-logic allows to obtain a systematic structure for the propositions, combining problematic Contexts with certain Intervention types, which follow determined generative Mechanisms, to deliver specific Outcomes. Therefore, design principles that are formulated according to CIMO-logic indicate what to do, in which situations, to produce what effect, and offer understanding of why this happens [13, 14]. Table 1 describes in detail each component of the CIMO-logic for constructing design propositions.

Table 1. Components of the CIMO-logic for the design propositions [14, 15, 17]

Component	Description
C - Context	The results that human actors aim to achieve and the surrounding (external and internal environment) factors that influence the actors.
I - Interventions	Purposeful actions or measures (products, processes, services or activities) that are formulated by the designer or design team to solve a design problem or need, and to influence outcomes.
M - Mechanisms	The mechanism that is triggered by the intervention, in a certain context, by indicating why the intervention produces a certain outcome. It can be an explanation of the cognitive processes (reasoning) that actors use to choose their response to the intervention and their ability (resources) to put the intervention into practice.
O - Outcome	Result of the interventions in its various aspects.

Design propositions represent one of the key knowledge products of DSR [13]. According to van Aken [12], rigorous design propositions need to be (i) field-tested, to allow obtaining evidence about the practicability of the design position in a specific context, and (ii) grounded, to help explaining the reasons for a determined action to origins the desired outcome in the intended context. Accordingly, van Aken et al. [18] show that the main product of DSR in operations management is the creation of innovative generic design that has been well-tested, well-understood and well-documented, to establish pragmatic validity. This generic design is supported by the design propositions, in order to understand where and how it can be used in the field.

2.2 CIMO-logic applications

Previous literature shows that CIMO has been applied in different contexts, mainly for performing research syntheses and for the creation of solutions to address and solve specific field problems, by developing design propositions. Table 2 presents a summary of different case applications of the CIMO-logic. Only papers that have a clear

specification and separation of each CIMO component were included in this summary. These cases were selected to provide a comparison and a better understanding on how previous studies have been addressing this prescriptive framework.

3 Case Study

3.1 Case description and research methodology

Our case study is focused on improving the role of industrial business associations (IBAs), with the use of DPs, to provide a better support to the internationalization of small and medium enterprises (SMEs). The ultimate goal is to transform IBAs in effective digitally enabled CNs.

A digital platform is defined by Spagnoletti et al. [1] as "*a building block that provides an essential function to a technological system and serves as a foundation upon which complementary products, technologies, or services can be developed*". Spagnoletti et al. [1] suggest that, to be effective, DPs should support the mix of three types of social interaction mechanisms for online communities: (i) information sharing, where free participation is allowed and actors make their own contents available on the internet and available to all members; **(ii)** collaboration, where actors follow rules and engage in activities that require group coordination, and participants adapt their behavior to others; and (iii) collective action, where a close coordination is required with actors following a common goal and standing by common rules, and decisions made by group members prevail over personal interests.

Accordingly, a digital transformation of IBAs was suggested, by proposing the adoption of DPs that can foster CNs and facilitate the three types of social interaction structures: information sharing, collaboration, and collective action. Following a DSR approach, these suggestions for improvement were defined in the form of design propositions (our artifact) with the help of the CIMO-logic. Therefore, the design propositions were developed to obtain detailed requirements and features for DPs supporting the internationalization of SMEs, situated in the specific context of IBAs.

Table 2. Applications of the CIMO-logic from the literature and examples of design propositions

Reference	Area	Aim	Context	Intervention	Mechanism	Outcome
[19]	Information systems	Design a portal for mapping competencies of an IT cluster	in a multi-actor cluster with a broad scope of technologies	building a common space representation	by reinforcing the motivation of actors to exchange and combine knowledge	serves to foster knowledge creation
[20]	Operations management	Synthesize a research program on tracking for operations management	industrial asset management	tracking composites of several individual products	basis of decision-making shifted from product type to individual product	more effective and efficient asset maintenance through condition-based programs. Lifecycle management to improve products through product development
[21]	Innovation management	Develop design principles that help multinational firms to re-design their new venture development process	in the context of a new venture development process for a venture in the bottom of the pyramid markets	a team must be established by	(a) creating a small entrepreneurial focused team, (b) having local based knowledge processes, (c) having competent & serious team members;	to achieve a positive new venture performance
[22]	Supply chain management	Develop a framework for disaster relief supply chain quality management	formulating strategy and structuring the resource portfolio	planning for lean and quality	design for Six Sigma; SIPOC Analysis	economic development; environmental performance; social equity
[16]	Energy ecosystems	Explore how firms together in the energy business ecosystems develop their business models	current business models make hay an expensive source for biogas production	biogas production is deeply integrated with biomass production leading to the possibility of nutrient cycling and organic farming	both farmer and biogas company achieve efficiency improvements and increased value of their offerings to customers	new business model and potential for increased total value creation through an industrial ecosystem
[23]	Open innovation	Direct SMEs in implementing, executing, and improving open innovation in their organizations	when developing an open innovation strategy	decide on innovation goals aligned to business strategy and obtain an innovation portfolio view	managing investment and risk	providing a view of the innovation which will be developed

These design propositions represent prescriptive knowledge and are regarded as mid-range theory, positioned between the case-specific and the universal [18].

To develop the design propositions, we have used both knowledge from practice and from theory, in order to obtain more robust design propositions that are field-tested and grounded [12]. The practical knowledge was obtained from different empirical studies that we have been performing in a specific research project. Results of these empirical studies can be found in [24–26]. Following a DSR approach, the aim of this project was to study and design new collaboration and information management socio-technical solutions to improve the institutional network support provided by IBAs to the internationalization of SMEs. The data collection was mainly based on interviews with IBAs and SMEs from different industrial sectors, both in Portugal and in the UK. A total of 44 interviews were performed in this project. For the theoretical part, we were based on theories and background on information systems, DPs, CNs, information management, international business, and business associations.

The next section presents our design propositions. To better illustrate the differences and to provide a more detailed discussion about the components of the CIMO-logic, we have chosen 6 main design propositions from our project (2 for each social interaction mechanism), presented into two different versions/interpretations of what can be the CIMO-logic components.

3.2 Version 1 of the CIMO-logic

In Version 1 (Figure 1), each design proposition comprises the same context (C), together with a proposed intervention (I), following one of the identified generative mechanisms (Information Sharing, Collaboration, Collective Action - M_{IS}, M_C, M_{CA}), to produce particular outcomes (O_{IS}, O_C, O_{CA}).

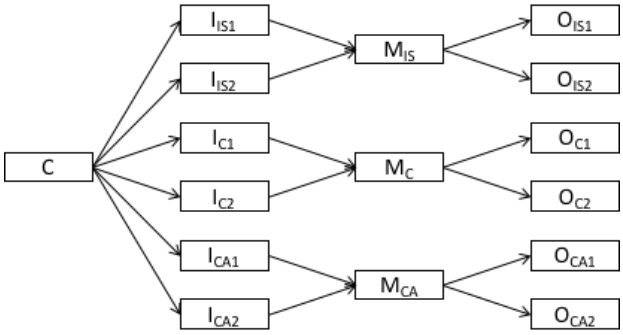

Fig. 1. Version 1 of the CIMO-logic

The general form of the design propositions Version 1 is (C,O)⟶(I,M). The interpretation[1] is *"to achieve outcome O in context C, enact intervention I to trigger mechanism M"*.

[1] This is a rigid interpretation. In a real case this is fuzzy e.g., "I might trigger M" or "to achieve O, I is probably a good way"

The 6 design propositions for Version 1 are:

The context (C) for all design propositions is *the improvement of the internationalization processes of SMEs with the support of DPs managed by IBAs* (this is the design context):

- **Design Proposition 1:** By managing and supporting the whole information lifecycle (information sources, information acquisition, information dissemination, and information utilization) (I_{IS1}), may trigger the intention and facilitate the processes of information sharing (M_{IS}), resulting in CNs of SMEs to have a more efficient and effective access, processing, and utilization of valued internationalization information (O_{IS1}).
- **Design Proposition 2:** By including a digital market observatory with market sheets, prospective reports and market studies (I_{IS2}), may trigger the intention and facilitate the processes of information sharing (M_{IS}), enabling to analyze, systematize, discuss and make available relevant information on emerging international markets that may be priority targets for the sector (O_{IS3}).
- **Design Proposition 3:** By developing roadmaps that are a combination of skills mapping (competences available in the IBA's members) and foresight (future trends, future requirements, potential partnerships, prospective markets and competences needed) (I_{C1}), may trigger the intention and facilitate the processes of collaboration (M_C), improving the provision of market intelligence services by the IBA and potentiate different types of collaborations (O_{C1}).
- **Design Proposition 4:** By having a marketplace for the placement of offers and market opportunities from foreign entities and clients (I_{C2}), may trigger the intention and facilitate the processes of collaboration (M_C), fostering matchmaking processes and allow users to apply and pursue new opportunities for international expansion (O_{C2}).
- **Design Proposition 5:** By including subcontracting services (I_{CA1}), may trigger the intention and facilitate the processes of collective action (M_{CA}), allowing large companies or international experienced companies to subcontract services from smaller companies or less experienced companies of the IBA, increasing the international activities of SMEs (O_{CA1}).
- **Design Proposition 6:** By including logistics services of transportation sharing (I_{CA2}), may trigger the intention and facilitate the processes of collective action (M_{CA}), allowing members to share transportation capacities and routes and promote collaborative advantages in terms of costs and optimization of resources for a proper international expansion and sharing economy (O_{CA2}).

3.3 Version 2 of the CIMO-logic

In the first version we have proposed different interventions, justified by the generative mechanisms of social interaction, and each of these interventions creates its specific outcome. However, a different interpretation can be achieved for the design propositions. In Version 2 (Figure 2), the context (C) is the same, but now, our previous social interaction mechanisms represent three general outcomes that we want to achieve, i.e. the outcomes wanted for the proposed DP is to allow to increase and

improve the social interaction structures of information sharing, collaboration, and collective action. Therefore, instead of having various outcomes, we now have three main general outcomes (O_{IS}, O_C, O_{CA}).

In Version 2, the proposed interventions (I) will trigger different mechanisms (M). After various iterations for the design propositions, we decided to introduce a new contribution and a new perspective for the CIMO-logic. Accordingly, to increase our understanding about the context under study, we opted for decomposing the mechanisms into two parts: (i) technical instruments (TI), which are the means and tools to facilitate the implementation of a proposed intervention; and (ii) social mechanisms (SM), which justify, and which are triggered by the interventions. In our view, this can contribute to obtain a more socio-technical perspective about the design propositions.

The general form of the design propositions in Version 2 is $(C,O)\rightarrow(I,SM)\vee(I,TI)\vee(I,SM\wedge TI)$. The interpretation is *"to achieve outcome O in context C, either enact intervention I to trigger mechanisms SM or TI or both SM and TI)"*.

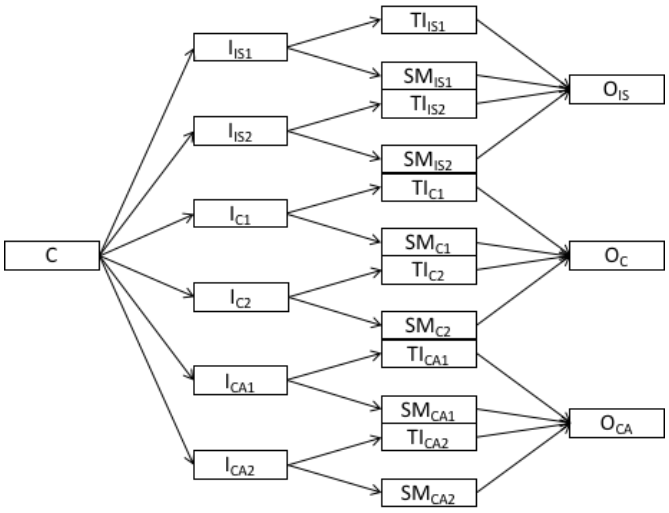

Fig. 2. Version 2 of the CIMO-logic

The 6 design propositions for Version 2 are (the context is the same of Version 1):

- **Design Proposition 1:** A more efficient and effective access, processing, and utilization of valued internationalization information (I_{IS1}), will enable managing and supporting the whole information lifecycle (information sources, information acquisition, information dissemination, and information utilization) (TI_{IS1}), as well as will promote discussion and knowledge sharing of opportunities (SM_{IS1}), improving the information sharing dimension of the CN of SMEs (O_{IS}).
- **Design Proposition 2:** Analyzing, systematizing, discussing and making available relevant information on emerging international markets that may be priority targets for the sector (I_{IS2}), will enable a digital market observatory with

market sheets, prospective reports and market studies (TI_{IS2}), as well as will promote discussion and knowledge sharing on opportunities (SM_{IS2}), improving the information sharing dimension of CN of SMEs (O_{IS}).

- **Design Proposition 3:** Improving the provision of market intelligence services by the IBA and potentiating different types of collaborations (I_{C1}), will enable the development of roadmaps that are a combination of skills mapping (competences available in the IBA's members) and foresight (future trends, future requirements, potential partnerships, prospective markets and competences needed (TI_{C1}), and will improve the technical reputation of the IBA (SM_{C1}), leading to more collaboration-intensive activities in the IBA (O_C).
- **Design Proposition 4:** Enacting matchmaking processes and allowing SME users to apply and pursue new opportunities for international expansion (I_{C2}), will develop a marketplace for the placement of offers and market opportunities from foreign entities and clients (TI_{C2}), and will develop the reputation of the IBA as trusted broker (SM_{C2}), leading to more collaboration-intensive activities in the IBA (O_C).
- **Design Proposition 5:** Incentivizing large companies or international experienced companies to subcontract services from smaller companies or less experienced companies of the IBA for increasing the international activities of SMEs (I_{CA1}), will increase the use of the platform subcontracting services (TI_{CA1}), as well as will increase trust levels between the IBA large and small firms (SM_{CA1}), increasing the joint activities among the IBA members (O_{CA}).
- **Design Proposition 6:** Enacting the sharing of transportation capacities and routes and promoting collaborative advantages in terms of costs and optimization of resources for a proper international expansion and sharing economy (I_{CA2}), will increase the use of the platform logistics services of transportation sharing (TI_{CA2}), as well as will increase trust levels between the IBA large and small firms (SM_{CA1}), increasing the joint activities among the IBA members (O_{CA}).

4 Discussion

Looking at the case applications of the CIMO-logic from the literature (Table 2), it is possible to see that this framework has been applied in different research contexts, which shows its applicability for example in managing processes or in the design of information systems. Regarding the CIMO components, it is clear in all studies that the context (C) is the one that provides no room for doubts in terms of its meaning. Each study addresses a specific problematic context, following a certain research objective. Likewise, the component of the outcome (O) does not appear to create difficulties in terms of interpretation. The outcomes in those studies are defined according to the result of the proposed interventions.

Nevertheless, the same does not happen when we are analyzing the components of the interventions (I) and the mechanisms (M). So, let's first recall the definitions of those CIMO components (Table 1). Interventions are defined as purposeful actions or measures proposed by someone to solve a problem or need, and that will influence the

outcomes. These proposed actions can take the form of a product, a process, a service or an activity. Mechanisms are then triggered by the intervention, by explaining why the intervention will produce a certain outcome.

Analyzing the case applications from the literature, most of the proposed interventions are in fact actions proposed by the research team to solve a problem. However, while some studies define more general interventions for their design propositions such as "*establish a team*" [21] or "*plan for lean and quality*" [22], others try to be more specific in their proposed interventions, with examples such as "*tracking composites of several products*" [20] or "*building a common space representation*" [19]. In the case of Hellstrom et al. [16], the CIMO-logic was used for the purpose of a research synthesis (looking at previous literature), rather than to develop design propositions. Thus, in this case it is not clear what are the actions or measures that the researchers want to propose, originating interventions that stand more like an explanation of a factor instead of a purposeful action.

In our case study we made an effort to be specific with the interventions for our design propositions, by defining particular features for DPs, demonstrated by examples such as "*managing and supporting the whole information lifecycle…*", "*having a marketplace for the placement of offers…*" or "*including logistics services of transportation sharing*". Nonetheless, we are also aware that to be more rigorous, an additional effort should be made by us and by future studies to be as specific as possible with the interventions in the design propositions, in order to facilitate the understanding from the users and targets for the proposed interventions, as well as to reduce ambiguities among the research community.

After that comes the mechanisms, which in our opinion is the CIMO component that generates more problems in terms of interpretation and understanding. Again, mechanisms in CIMO are used to support the idea that a certain intervention will produce a determined outcome, or, in other words, mechanisms offer an understanding of why an intervention happens. The six case applications from the literature present very different interpretations and perspectives for the mechanisms in the CIMO-logic. To exemplify, in some cases the mechanisms are considered as specific tools "*design for Six Sigma, SIPOC analysis*" [22], or actions "*managing investment and risk*" [23]; "*creating a small entrepreneurial focused team*" [21].

During the development of our design propositions, we had difficulties to clearly define this component of the CIMO-logic. Those difficulties were also justified by the lack of a more agreed and unified version of this framework in the literature. That is why we chose to present in this paper two different versions and interpretations for the design propositions (in fact, additional versions could have been defined): (i) the first one considering our generative mechanisms as the social interaction structures of information sharing, collaboration and collective action, which in our view help to justify the outcomes of the proposed interventions; and (ii) the second version, where we introduce a new view for this particular framework, by dividing the generative mechanisms into technical instruments and social mechanisms, to obtain a more socio-technical perspective about the design propositions.

The design propositions from our case study could be used by IBAs, researchers and practitioners for the design and development of more effective collaborative DPs as socio-technical systems for supporting SME internationalization. By explicitly defining each component of the CIMO-logic, we believe that having the design propositions

defined in this way can become the proposed interventions more clear and transparent for the potential users and stakeholders.

We can conclude this discussion by arguing that the application of the CIMO-logic is very much subject and dependent of the context and of the view of each design or research team. In our view, each component of the CIMO-logic needs to be clearly defined and explicitly presented when developing the design propositions. In addition, the connections between each CIMO component need to be well justified to make sense for both researchers and practitioners. Another important aspect is to increase the number of studies that can apply the CIMO-logic, in order to have a good progress on its discussion and evolution as a prescriptive method, as well as to contribute for making this framework well established and well framed in terms of research.

5 Conclusion

This paper aims to contribute to better design CNs by exploring the CIMO-logic approach. By showing and discussing both examples from the literature and from our own work, we believe that we have produced important insights for the future development of a prescriptive research framework supporting researchers in using the CIMO-logic for the design of CNs and cognitive systems mediated by DPs.

We hope that this study can help clarify each component of the CIMO-logic, to allow for further applications of this framework in different research contexts, and to help future studies in developing more rigorous design propositions, as innovative DSR artifacts. This study can also be further extended by performing a systematic collection and analysis of the previous literature of CIMO, with the aim of trying to obtain a more agreed and unified version for future exploitation.

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