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- Surveying Strategic Options Development and Analysis applications around the world
- Evaluating the scope of Strategic Options Development and Analysis applications

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Surveying applications of Strategic Options Development and Analysis (SODA) from 1989 to 2018

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Abstract

Strategic Options Development and Analysis (SODA) is a well-established problem structuring method (PSM) used to tackle problematic situations for at least 30 years within the discipline of Operational Research (OR) and other fields. The aim of this study is to assess the ways academics have been implementing SODA methodology in different fields of knowledge and practice. We started by exploring the SODA history followed by the evaluation of published articles associated with the practical applications of SODA from 1989 (publication date of *Rational Analysis for a Problematic World)* to 2018. We searched relevant databases and studied 200 SODA-related articles, we examined the scope of each application, whether as a sole SODA application or as a combination with other methodologies. We also investigated which elements of the methodology have been used. Our findings suggest that SODA through its associated technique of cognitive mapping has been used in conjunction with other methods. SODA is a participative methodology designed to provide dialogue, reflection, learning, consensus and commitment, but the sample of articles surveyed indicate that its use has been limited to helping modelling the problematic situation and providing a common understanding to participants. Other core activities, such as group negotiation support, have not been fully used. Our findings suggest that SODA is a methodology suitable to different contexts and its

practice has grown steadily over time but that to exploit the full use of its activities, its creators need to produce a set of constitutive rules to guide the applications.

Keywords: problem structuring; SODA; cognitive mapping; survey; constitutive rules

1. Introduction

Operational Research (OR) methods and methodologies have been recognized as a modern and valuable approaches for improving efficiency and productivity especially through mathematical modelling, optimization and iterative computing tools (Taha, 2007; Kirby, 2000). In the period that followed the 'OR Golden-Age' (the 30-year cycle from 1940 to 1970), further investigation and discovery within OR, with new approaches were explored. At that time, its optimization nature was essentially complemented by new paradigms of fresh elements and further ramifications for the discipline (Kirby, 2007). One of the most developed paradigms was the so-called learning paradigm in OR which underpins a number of methodologies developed under the umbrella of *'soft OR'* or *Problem Structuring Methods* (PSMs). Since this foundation in the early 1970s, it can be said that PSMs have been evolving, maturing and expanding as a valid field. Despite this steady evolution, it was only in 1989 with the publication of the book *Rational Analysis for a Problematic World* (henceforth RAPW) by Rosenhead (1989) that the area was formally defined in the UK. This was a wider recognition of PSMs, their usages and merits (Shaw, Franco, & Westcombe, 2006).

The book compiled the theoretical basis and applications of the best-known soft approaches by: Checkland (SSM), Eden (SODA), Friend (SCA), Rosenhead (Robustness Analysis), Bryant (Drama Theory), Nigel Howard (Metagame Analysis) and Peter Bennett, Steve Cropper and Chris Huxham (Hypergame). According to Rosenhead (2006), *'Problem Structuring Methods'* are a set of methods that aim to tackle and provide analytic assistance to problematic situations that are characterized by: (a) multiple actors; (b) differing perspectives; (c) partially conflicting interests; (d) significant intangibles; and (e) perplexing uncertainties. A revised version of the book - '*Rational Analysis for a Problematic world-revisited'* (Rosenhead & Mingers, 2001) updates the current developments on the so-called 'soft' approaches and adds some new ones including multimethodology (Mingers J. , 1997a; 1997b). As a result of the two editions of this book, the use of 'soft methodologies', under the flag of '*Problem Structuring Method*s' (PSMs) has now become widely accepted within the OR, Systems and IS UK communities.

The term `PSM' would appear to be, at least, as Friend (2006) argues, not only a better substitute for 'soft OR' but a better descriptor of the current soft systems practice in the UK:

[…] since that phrase (soft OR) describes a tendency within OR, which is anything but a soft option in the challenges it presents to those of us who seek to engage with decision-makers in a responsive and flexible way". He also finds the PSM label to be more: "… formal-sounding collective label [. . .] for a body of methods, which, on their own might have found it more difficult to claim places on crowded academic syllabi, or indeed on the repertoires of busy OR consultants. (Friend, 2006).

However, PSM is not a term fully accepted by the MS/OR community, Eden and Ackermann (2006) in particular question the suitability of the term:

[...]. The label is not descriptive - they seek to facilitate agreements to act, they do not just structure problems. [...] in SSM, there is an emphasis on 'implementing 'feasible and desirable changes'; and in SODA [...] the process of mapping focuses on being 'action oriented', reaching agreements, and on issues of implementation and project management. (Eden & Ackermann, 2006)

Checkland (1978) states that 'hard (also known as 'classical') systems thinking' assuming that the world is formed by systems that can be objectively modelled. By contrast, 'soft systems thinking' purports that the rich complexity of the world can hardly be modelled (Checkland, 1985). Rather, systems concepts can be convenient in structuring our thinking and learning about the situation, a fertile field in which to debate and accommodate around the nature of the problem, rather than to 'solve' it (Checkland, 1999). In this sense, the right term shall be employed, avoiding any wordplay such as between 'problem-solving' *versus* 'problem-finishing/structuring' in order to align process and expectations among the involved (Eden C. , 1987).

It is now 30 years since the date of the first edition of RAPW and over this stretch of time PSMs have been widely applied in OR research and practice (Mingers & Rosenhead, 2003). PSMs had been seen as a 'wide-brand group decision support system', where the expression 'wide brand' designates their ability to address problems that have not been pre-formulated and, may even have completely diverse structures (Eden & Heijden, 1995; Wagner, Vogel, & Eden, 1997; Eden C. , 1995).

In terms of the actual use of these PSMs, '*Soft Systems Methodology*' (SSM) is one of the most studied as can be seen in many occasional reports on surveys: Hanafizadeh & Mehrabioun (2018); Mingers & White (2010); Van De Water, Schinkel & Rozier (2007); and, Mingers & Taylor (1992). Moreover, a thirty-year retrospective of SSM's principles and practice chronicled by the creator himself (Checkland, 2000) was published, together to the main lessons learned from its applications in different areas (Checkland & Scholes, 1990). Despite being (alongside with SSM), one of the most

used PSMs, not many studies have been done to assess the use of 'Strategic Choice Approach' (SCA) and 'Strategic Options Development and Analysis' (SODA).

Therefore, the research proposed in this article was to evaluate SODA methodology in MS/OR and beyond and, find out the extent to which it was implemented and performed over the defined period. The objectives of this study are:

(a) Ascertain the context of applications: what areas, sectors, and places (countries and regions) in which this methodology facilitated tackling problematical situations; and,

(b) Understand the way in which SODA was used in the applications by identifying the elements, activities and level of each empirical study.

In order to achieve this, we assessed the scope of articles reporting practical application of SODA, published from 1989 to 2018. This survey used a design criterion that included a set of articles extracted from database searches by using combined related keywords. The results of this study should be of particular interest to OR consultants and OR educators.

This is important as the outcomes of this research are likely to inform the future of OR professional practice. Only by exploring this, can we derive answers to questions such as: What exactly do we practice under the name of SODA? Do we practice what we learn? These research questions drove this project and at the end, we had important clues. It had already been pointed out that courses teaching PSM are in limited rigour, leading to poor teaching and even worse practice (Ackermann, 2015). By understanding and evaluating the ways in which SODA has been interpreted and applied in practice is also to 'walk the walk' and to be able to cast critical eyes towards the future and provide a feedback for past practice. This is especially useful regarding what seems to be the trend in the field of OR and management and, the prospects for sharing knowledge in the interest of future studies and education, by knowing how theory and practice are misaligned. Lessons herein gained might thereafter be embodied into OR training courses. The paper also explores the need for SODA to have a set of constitutive rules and although we do not produce them, we provide some ideas for this important task. We argue that the task of producing SODA constitutive rules, as Checkland did for SSM (Checkland & Scholes, 1990), lies on SODA's creators that is Eden and Ackermann.

This article is organized as follows: after this introduction which contextualizes our research and describes our objectives, Section 2 sketches SODA's journey by tracing its origins and fundamentals from cognitive psychology, cognitive mapping's basis, to current practice. In Section 3, we outline framework underpinning our survey and categorisation of SODA applications. Section 4 outlines the theoretical position and the research strategy structured in four stages: (i) article collection, (ii) article filtering and screening, (iii) article classification; and (iv) analysis and discussion. In Section 5 we

outline the five dimensions by which we classified and categorised the 200 papers surveyed: (i) fields of application, (ii) country, (iii) level of application, (iv) activities used during the application and (v) SODA perspectives used during the application. In Section 6, we discuss in detail our findings in each of the dimensions, including the implications and wider significance of our research. Finally, in Section 7 we advance some conclusions and final remarks. In Section 8, the limitations of the work together with some recommendations for future research are advanced.

2. Tracing SODA Developments

In this section, to set the context of the paper, we provide a brief account of SODA's history and development over the years. 'Strategic Options Development and Analysis' (SODA) offers a framework for designing problem solving interventions. Overall, its theoretical position is underpinned by *subjectivism*, in that it is based in the belief that each individual has his/her personal view of the world and consequently, of the particular problem in question (Rosenhead & Mingers, 2001). This individual belief is based on his/her wisdom and experiences can be elicited through verbal communication (language). Language (written or spoken) and thinking are taken to be the basis for understanding how people view their idiosyncratic world (Eden & Huxham, 1988). This is also the way SODA addresses the issues of organizational problem-solving. As a result of the model's construction (i.e. the *cognitive map* developed from individual interviews, or, the *cause map* constructed by a group), this *explicit* process is a prime quality of SODA. It allows the particular individual(s) to become aware of some aspects of the problem that they might not have realized until then. This could result from the use of natural language (spoken) during an interview, a conversation, a 'think-aloud technique', a brainstorming session or just a verbal reflection of his/her thinking. Whatever the case, the predominantly participative process is seen as appropriate for both the facilitator/consultant and the individual/client (Eden & Sims, 1981).

The attention to the individual himself/herself is driven by the 'Theory of Personal Constructs' (Kelly, 1955) which makes use of concepts (rather than emotions) to bring sense to this individual world, in order to identify the problem, to manage and control it. According to this theory, "*Whatever the world may be, man can come to grips with it only by placing his own interpretations upon what he sees. […]. This […] makes him responsible and suggests that it is quite inappropriate for him ever to claim that his conclusions have been dictated by any nature other than his own*" (Kelly, 1955:4). Furthermore, this theory treats the individual as 'a scientist' always seeking to make sense of the world in order to act within and upon that world (Eden & Ackermann, 2004). On this basis, SODA can also be called as a 'facilitative device' which is able to deal with both *content* and *process*, thereby, enabling psychological negotiation amongst team members (Eden C. , 1989).

2.1 SODA: Its Beginning

The beginnings of SODA can be traced back to when Eden (1977) exposed the still uncommon concepts of cognitive psychology and sociology that he was applying to his research. He was experimenting with new methods of modelling by representing the situation through hierarchical organized dichotomous constructs. In the following year, Eden (1978) reported his participation in a project for developing an interactive computer simulation model of organizational decisions-makers and, their environment within an OR program. This is where giving meaning to the perspectives of such decision makers was a seemingly impossible task. By using a system of constructs, they succeeded in defining the situation and relating values, norms, ideals, objectives, goals and roles. Noting the difficulties (e.g. conflict of values, different cognitive styles, divergent purposes *etc.*) but also the necessary involvement of all parts and the need for a mutual understanding. Eden concluded by suggesting a closer relationship between OR and the behavioural sciences.

By 1979, the cognitive map was seen as shaping a basis for dialogue between the decision maker and his/her own world. As such, it could be a device for intervention and navigating change (Eden, Jones, Sims, & Gunton, 1979). Furthermore, ignoring subjective and non-quantifiable factors meant a naïve and inaccurate way of modelling; beyond the risk of offering "*a solution to 'half a problem'*" that means "*no solution at all*" (Eden & Sims, 1981:69). A series of practical cases such as Armstrong & Eden (1979), and Eden & Smithin (1979) were subsequently published. These presented some reflection on the practical challenges of this highly participatory methodology. These related particularly to the difficulties in uncovering, understanding and translating (on a map) the subjective world of each individual - a reality which is unique to him/her. Moreover, by involving many people in the process of negotiation and validating a complete model, this means a particular problem will be thoroughly owned by the group but also, "*. . . a complicated drama unfolds which involves power, influence, negotiation, game playing, organization politics, complex social relationships with real people not merely office holders*" (Eden & Sims, 1979:2).

During the decade which followed, experimentation with the methodology continued in many contexts. This was especially in policy making cases (Eden, Sims, & Jones, 1979; Jones, Eden, & Sims, 1979), but not limited to them. Other examples include marketing (Eden C. , 1985; Eden & Jones, 1980; Jones & Eden, 1981), report writing (Armstrong & Eden, 1979) and development of new ways of fundraising for charity (Eden & Smithin, 1979). All these scenarios provided lessons and the potential for new learning. The studies also showed that the methodology was able to work satisfactorily from the users' point of view as important aspects of the problem were being raised. It was overcoming any lack of understanding regarding the model and, the related involvement by managers and executives (*i.e.*, if compared to traditional models commonly used). It also brought

conflicting views to the light of reality. However, this was in a de-personalized way, even if sometimes there was formal criticism by peers within the OR discipline (Machol, Eden, & Jones, 1980).

2.2 Cognitive mapping: SODA's core

Cognitive or cause (or causal) mapping is a fundamental part of the SODA approach (Rosenhead & Mingers, 2001). By using this process, it is possible to visually capture and structure 'means-end' (or issue-outcome) relations, generating the context through chains of action-oriented argumentation (Ackermann & Eden, 2010). Mapping provides the 'subjective picture' (one could argue not exactly the 'objective truth') of the problem, portrayed and reflecting the intrinsic reality of the individual (Ackermann & Eden, 2010). Sociologists Thomas & Thomas (1928) - in a classic reference available in a reprinted version (Thomas W. I., 2017), commented on this phenomenon; '…*if men define events to be real, they are real in their consequences*'. W.I.Thomas' contribution to the study of the interaction leads researchers to comprehend that the social conduct results from the multiple perspectives which in turn is produced by the meanings experienced by the individual (Ball, 1972). From there, the exercise of 'defining a situation' is conceived of as the sum of recognized information which encompasses the culture, point of view, perspective and everything that encounters the individual in his/her own micro-world which mean a 'social construction of reality'. In her essay about how to teach and learn PSMs, Ackermann (2011) encourages practitioners to appreciate and capture the different perceptions which drive the individual behaviour from this panorama. It provides insights into possible ways of structuring the situation by starting with the description of the problem by its particular owner (Eden & Sims, 1981). Eden (1992) further notes that the capacity of a map to be a 'model of cognition' depends mostly upon two attributes of the mapping method. These are: (i) the adequacy of the cognitive theory which guides the modelling or technique and (ii) the method of elicitation of cognition.

Although this was the original problem structuring design over time, the one-to-one approach was eventually replaced by the direct use of group mapping. This conclusion was made recently by Eden & Ackermann (2018) and it is tested in this study by analysing the reported cases. The main argument behind this shift is the time-consuming features associated with the original design. Apart from restricted availability, this reason had already been reported after the early practice involving team development (Armstrong & Eden, 1979).

Therefore, the individual, face-to-face interaction process (with the facilitator in the role of interviewer, eliciting conversation) was replaced by a 'communal' reflection on the problem,

expressed through collective statements. This is the 'oval mapping' (also known as 'post-its') technique (Ackermann & Eden, 2010; Ackermann & Eden, 2001). In fact, this time-saving may actually be an alternative innovation for working with large teams (Eden C. , 1985), while also integrating the working group from the beginning.

Another very important aspect of the cognitive map is the way of recording the statements in the nodes. They shall be written as a 'call to action', avoiding replication of the language used and, suggesting an option for changing the situation in a positive way. Additionally, in keeping with Kelly's theory (Kelly, 1955), in order to make sense of situations we may use similarities and differences to make the statement concise. As natural language carries words which can have many different connotations and implications, in this case, ambiguity could be minimized, with the alternative pole improving understanding of the primary pole (Georgiou, 2011).

In this sense, Kelly (1955) argues *"[...] a construct is a 'black and white' affair, never a matter of shadings or of 'greys'"* (1955:10). Thus, cognitive mapping seeks to identify each statement as having two contrasting poles (Eden C. , 2004). For practical purposes, the contrast is separated by three dots ('…') which is read as 'rather than'. For example, *"mapping what the actor wants (and what they want others) to believe ... mapping actor's developed beliefs"* (Georgiou, 2009:691, in Figure 1 "Understanding SODA through a SODA map").

However, Kelly also assumes that this is '. . . *the point where many of his readers first encounter difficulty in agreeing with him'* (Kelly, 1955:10). That is another important aspect to be evaluated by this current study, whether practitioners are using constructs (bipolar) or concepts (single pole) in building cognitive maps. Kelly also reassures that ". . .*a construct is the basic contrast between two groups [...] Certainly it is important not to consider a construct as another term for a concept, else a major sector of the arena in which constructs function will be obscured from view*" (1955:10).

Cognition elicitation depends on the interaction between articulation and thinking, which promotes an 'added value' process (Eden C. , 1992). It is usually obtained through interviews. Hence, we cannot ignore the relevant function of the interviewer, the map coder(s) and facilitator(s), as all the three roles may be carried out by the same person/people. In this case, his/her/their skills as inquirer, listener, interpreter and languages' coder will bring (or not) quality and meaning to the graphical representation of the problem, at least from the interviewee point of view (Eden C. , 2004; Eden, Jones, Sims, & Gunton, 1979). At the group level, the facilitator can be encouraged (i) to promote an effective teamwork *process*, assisting them to reach feasible agreements; and (ii) to adapt a framework that enables a built model, thus, embracing all *content* addressed by the group (Eden & Ackermann, 2001).

In this section, we have sketched SODA's main characteristics and traced its journey from origins and fundamentals from cognitive psychology, cognitive mapping's basis, to current's day practice in which it has become one of the most used soft OR/PSM amongst the MS/OR field. The popularity and steady use of three PSMs in particular: Soft Systems Methodology (SSM); Strategic Choice Approach; and Strategic Options Development and Analysis (SODA) have been corroborated by Eden &Ackermann (2006), Mingers and Rosenhead (2003), amongst others. In the next section we outlined our methodological strategy and out theoretical position underpinning our in-depth analysis of SODA applications.

3. A framework to survey SODA Applications

According to its originators, Eden & Ackermann (2001), SODA methodology is framed by four main interacting theoretical perspectives: (i) the individual (cognitive psychology); (ii) the organizations being represented by the group of people involved in the problem structuring and, who outline the multiple perspectives; (iii) the consulting practice mainly expressed by the interaction involving the facilitator and the individual and, between the facilitator and client group, and; (iv) the technology and techniques for allowing construction of a visually interactive model.

Figure 1 illustrates the *Model of SODA Applications* that the authors have used to assess SODA applications in this survey. The model follows the above mentioned four theoretical perspectives that inform SODA. The model proposed can be seen as an initial attempt to create SODA *constitutive principles* to assess the way SODA principles have been applied. In our view, to set out a set of constitutive rules for SODA (in its various modes) is a task that lies entirely on its creators camp, not on practitioners or researchers of SODA.

The *Model* depicted in Figure 1 can be used to explore how SODA constitutive principles might be elucidated. The model includes three main *activities*: (a) modelling the situation; (b) providing common understanding; and (c) supporting group negotiation, towards a suitable direction forward. The individual plays a defined role in the first activity, through interview cycles. An open-ended conversation instead of a more structured research interviews could be an initial stimulus for deeper searching about the problem, avoiding anything that can be characterized as a diagnosis (Eden & Smithin, 1979). In subsequent exchanges, he/she could share perspectives and understandings as part of the client group and agree a view of the problem. The facilitator supports all three phases. The main technique of cognitive mapping is also present in all stages of the process. Throughout these phases, technology may or may not be used, depending on the nature of the stage(s), actual availability of support software, recording devices, and so on. In this study, we investigate the use of the technique of cognitive mapping in terms of how it is used with the individual and/or group approach. We explore these perspectives (except for the technological one) throughout this paper.
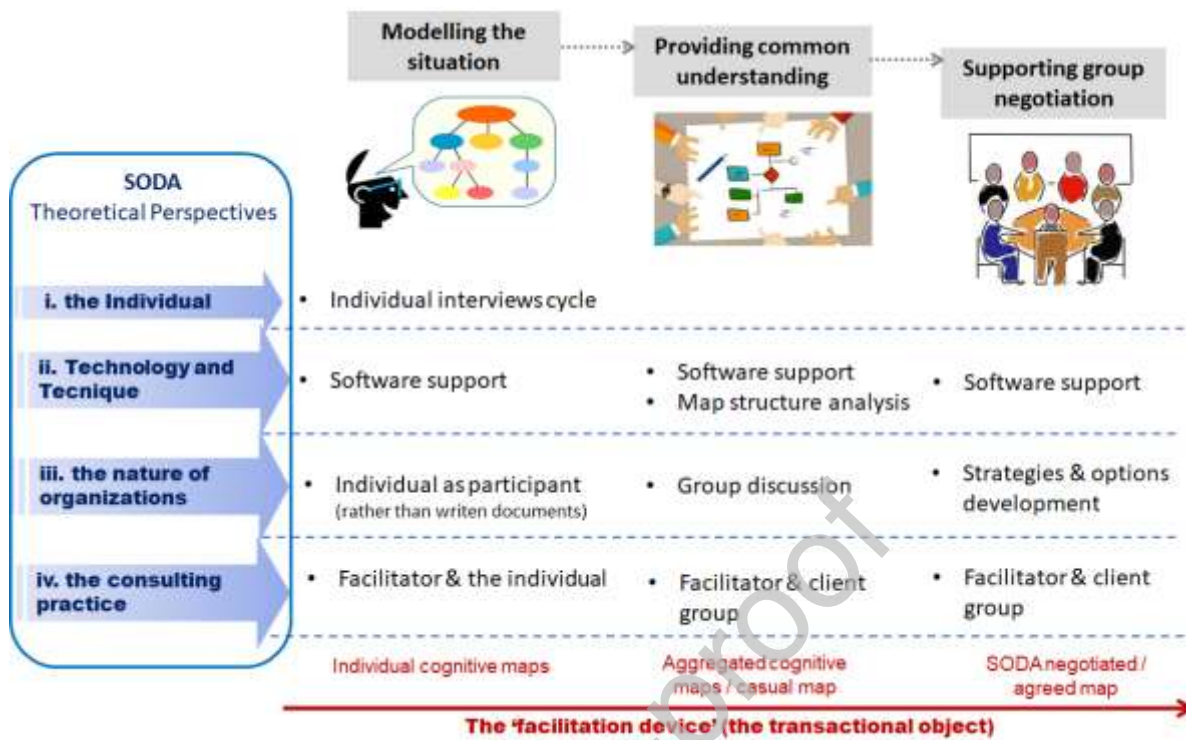
Figure 1: Model to assess SODA Applications - adapted from Eden & Ackermann (2001).

This research was limited to the concepts as presented above that have explicitly used SODA. However, it is worth mentioning that in the 1990s, SODA evolved and its creators developed a strategy making methodology called JOURNEY (JOintly Understanding and NEgotiating strategY) as result of the creators' consulting work (Ackermann & Eden, 2010; Eden & Ackermann, 2018). The model also incorporates the four perspectives that informed the SODA methodology: *the Individual, Technology, Nature of organisations and Consulting practice*.

Conceptually, this model provides the lenses that the authors have used to assess the papers that claimed to have used SODA. As far as we know from all the well-known PSMs, only SSM has produced its constitutive rules. And it is worth mentioning that when Checkland produced his five statements that set out SSM constitutive rules, he did as a way of formalising previous attempts by Naughton (1977). He thought that rather than relying on SSM secondary literature it was necessary for him to *define* SSM:

'These five statements, […] define SSM sufficiently for it use to be *discussed coherently'* (Checkland & Scholes, 1990, p. 287, our italics).

He adds:

> What follows is an account of new Constitutive Rules of SSM […]. They are written in the
> form of an account of the family resemblances which characterise the whole spectrum of SSM
> use (Checkland & Scholes, 1990, p. 286).

Our model does not set out SODA constitutive rules but can be seen as an initial attempt to have a formal set of guides to rule SODA applications; and our call to the creators of SODA is that, in order to *discuss coherently* the use of SODA, a similar effort is needed. It is worth noticing that to produce SODA constitutive rule does not mean that its use will be *straightjacketed*; the idea is that they will act just as formal guideline. Again, as Checkland recalls:

> It is perhaps superfluous to point out that the new Constitutive rules will be themselves be an
> 'ideal type' construct, its purpose being, […], to enable a particular kind of discourse to take
> place, rather than to pigeon-hole part of the world.' (Checkland & Scholes, 1990, p. 286).

4. Theoretical position and methodological strategy to survey SODA's practice

The present article is to our knowledge the first survey on SODA methodology practice. However, there are similar studies in relation to other PSMs. Among them, we highlight the work of Hanafizadeh and Mehrabioun (2018) which was our most important inspiration especially in relation to the methodology which was detailed in the next section. In this article, the authors evaluated *Soft System Methodology* (SSM) from a set of 149 articles published from 2000 to 2015. Moreover, the classification process adopted (that is the allocation of each article into a category), was not an easy task and probably not accurate. Each article reporting a case study involves more than just one knowledge application area. Furthermore, building an information structure which is part of a classification system requires decisions to be taken and consequences that may lead to some loss or gain for one or another area (Bowker & Star, 1999). For that reason, in this research we abandoned any formal or bureaucratic shape and adopted a more *ad-hoc* process for classification. The present survey focused on practical frameworks that included any evidence of SODA even if it was not a canonical application.

On the other hand, there are cases that practitioners had used some of the principles of PSM without knowing they were using some of the principles underpinning PSM. These applications are the subject of Yearworth and White (2014)'s research when they explore problem structuring applications using three cases from engineering organisations in search of a generic constitutive definition of PSM, in order to identify cases where a problem was structured. As far as we are aware, from all the PSMs, only Checkland has declared some constitutive principles for his SSM (Checkland & Scholes, 1999, p. 285). Therefore, in this paper we have made two assumptions: (i) we searched for SODA applications in which the authors have explicitly applied SODA; and (ii) although SODA's creators

have not spelled out its constitutive principles, we assume that the authors of the articles searched here have implicitly accepted the underpinning assumptions and principles of SODA.

4.1 Theoretical position

In this paper, we took the broad assumption that documents (articles) are texts that can be read. This situates our theoretical position as one that treads a fine line between, a *realistic ontology* - by assuming that there is a reality there to be discovered by analysing documents; and at the same time, we adhere to an *interpretivist epistemology* by treating the documents as privileging particular perspectives in regards to SODA applications.

Following the above stated theoretical position, our research strategy combines two approaches: (1) it deploys Bibliometric[1] (sometimes called Scientometrics) methods as quantitative analysis and statistics to ascertain the number of articles using SODA; and (2) complements the analysis with a careful reading of the documents to ascertain a detailed account of the SODA applications the articles are claiming to have used. These two steps are aligned with the above ontological and epistemological elements that underpin our theoretical position.

The methodological approach included four main sequential phases; (1) Collection; (2) Filtering and screening; (3) Reading/categorisation; and (4) Analysis sand Discussion. These stages are illustrated in Figure 2.

4.2 Methodological approach and methodological stages

To investigate the dynamics and evolution of SODA, we employed content analysis of academic literature in the form of journal articles over the period under study. Overall content analysis concerns with the semantic analysis of a body of text, in our case, the content of large bodies of text (articles).

To structure the content analysis, we used and slightly modified the four-stage approach proposed by Bandara, Furtmueller, Gorbacheva, Miskon, & Beekhuyzen (2015). This is just one approach among many which also provides an assessment of computer-supported tools to help in all the different stages of relevant data. The four stages are: (1) Extraction of relevant literature; (2) Organisation and preparation for analysis; (3) Coding/categorisation; and (4) Discussion and presentation.

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[1] Thomson Reuters. (2008). *Using bibliometrics: A guide to evaluating research performance with citation data* (White Paper from Thomson Reuters). Alexandria, VA: Author. Retrieved from http://ip-science.thomsonreuters.com/m/pdfs/325133_thomson.pdf (accessed 17 March 2020).

In our survey, we loosely adopted the above steps and designed the following steps the survey: (1) Extraction of relevant literature- Collection of articles; (2) Organisation and preparation for analysis: Filtering and screening; (3) Reading, coding and categorisation; and (4) Classification and discussion of results. The detail of each phase is depicted in Figure 2.
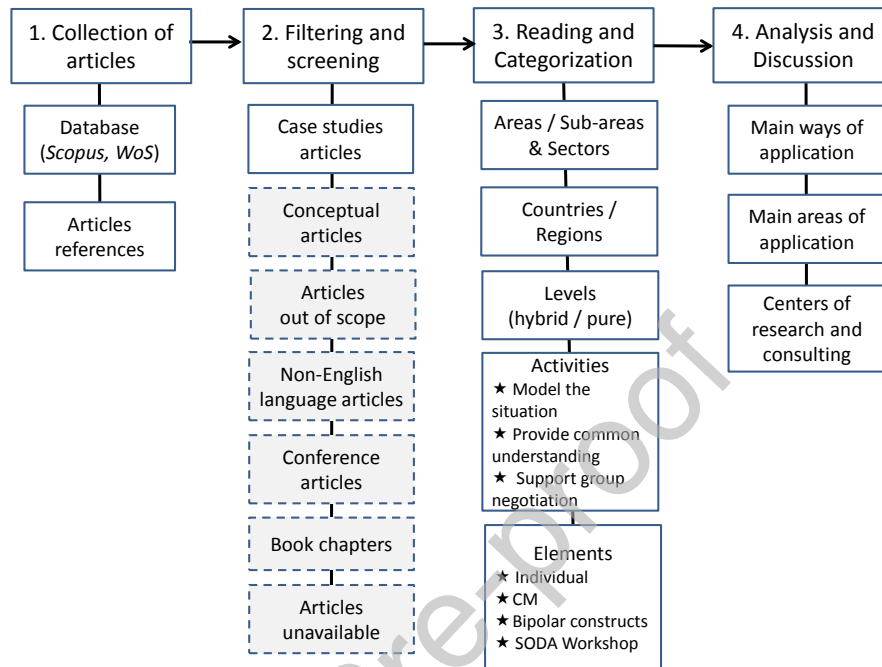
Figure 2: Methodological framework

4.2.1 Extraction of relevant literature - Collection of articles

The study involved searching for a collection of articles that included the practice of SODA. These articles were extracted from two different databases: *Scopus* and *Web-of-Science* (WoS). The secondary source was the actual references cited in these articles and as such, they were not directly from the original data sources.

Apart from being an expression for a soft drink, the word 'soda' has other acronyms, including an algorithm in the OR discipline. Furthermore, a 'cognitive map' has several associated derivatives as well. By using combinations of keywords as listed below (wildcard '*' was used), the result was a smaller, more realistic and manageable sets of articles:

a)   'SODA' <and> 'operation* research';

b) 'SODA' <and> 'cognitive map*';

c) 'SODA' <and> 'strategic option and development analysis';

d) 'SODA' <and> 'Eden';

e) 'SODA' <and> 'Ackermann';

f) 'cognitive map*' <and> 'Eden' <and> 'Ackermann'; and,

g) 'cognitive map*' <and> 'operation* research'.

The *articles* and *articles in pres*s eligible for our study review met the following criteria:

a) Only articles written in English language.

b) Only articles from scientific journals, leaving aside conference papers, dissertations, theses and books, since articles have already been subjected to certain scientific validity by peers, according to general publication processes.

c) Articles related to any practical aspects of SODA, discarding the ones that exclusively mention the conceptual development or methodological approach of SODA.

d) Articles published from 1989, which refers to the first edition of RAPW, up to 2018 and its contemporary period.

4.2.2 Organization and preparation for analysis: Filtering/screening

At this stage, we filtered and screened the initial collection of articles by reading: the title, abstract and keywords. In case of doubts, we also quickly looked at the entire document. This process resulted in three types of articles:

a) Articles related to the practice of SODA, which were kept for next step of the process.

b) Conceptual articles that refers to the scientific fundamentals of SODA. They were not part of the final database, but some of them were explored for this article.

c) Articles that did not refer to SODA at all, which were disregarded. We allude here to some articles that had passed through the combined keyword filter. However, they do not refer specifically to a SODA application. In such cases, the keywords were mentioned in the literature review or discussion sections for instance.

4.2.3 Reading, coding and categorisation: Both authors read the articles and discussed the classification in three sessions. In the first one each of us prepared a list of both articles that 'met/not met' the criteria set in (2) above. Articles which (according to each of the authors) did not meet the criteria were exchanged and another session was schedule. In the third iteration, the list was discussed, and a final list was agreed. Following initial screening, the 537 entries corresponded to a set of 259 unique documents. In summing up the full reading process, the set of papers has been complemented by 25 new articles from cross-referencing and, 84 that were excluded due to non-

applicability. As it will be explained in the next section, after careful reading, we ended up with a total of 200 articles.

5. Classifying and categorizing applications of SODA from 1989 to 2018

Our intention was not only to survey all articles related to SODA, but also to have a diverse and representative collection of baseline articles leading to reliable findings. Therefore, we considered any article that dealt with the topic area - even if playing a minor role in the context of application. The articles were initially analysed by reading the title, abstract and keywords. If necessary (such as in case of doubt), full paper content was scrutinised.

We ended up with a total of 200 articles in the database which included exclusive empirical cases and articles reporting methodological and empirical applications of SODA. The detail search and screening process for the number of articles surveyed is shown in Figure 2. Due to the length limitation of this paper, we cannot include the **200 SODA articles** studied, the complete list of articles that are part of the database are available from the authors as **Appendix 1: "List of SODA articles reviewed".**
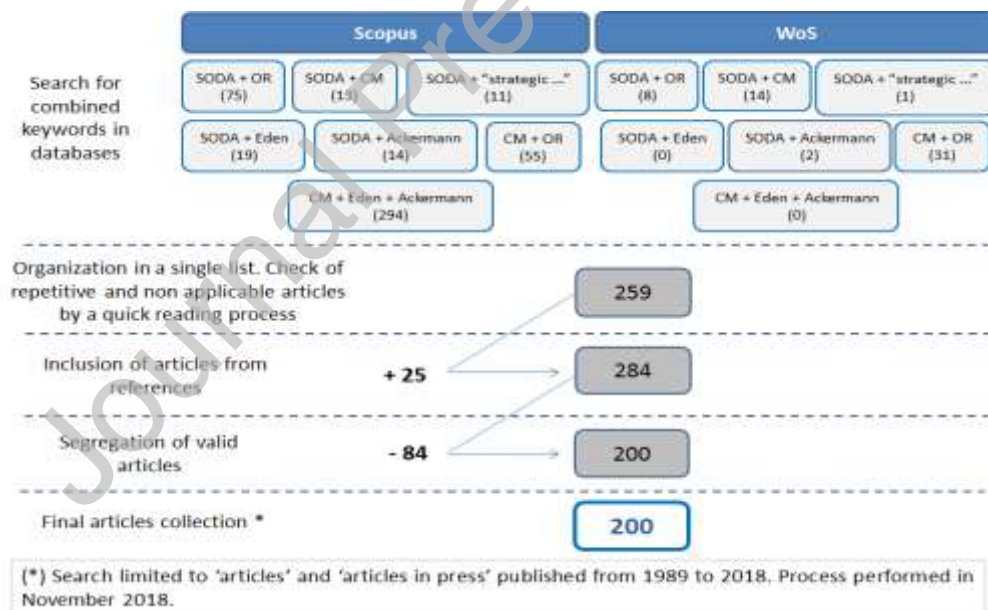

Figure 2: Process of collecting SODA articles

In the next section, we outline the five dimensions in which our categorisation of SODA application is based. The first three dimensions: fields of application, country and level of application are used to find out the scope of fields of application and to assess the use of SODA around the world. The last

two dimensions: Activities used during the application and SODA perspectives used during the application are related and taken from the framework depicted in Figure 1.

5.1 SODA's areas and sectors of applications

That may include areas such as organizational management, healthcare management, educational system management, information systems, knowledge management or any other. By reading each case study (especially in the description of research questions), we were able to extract the necessary information. We did not use any previous classification as guidance. We tried to be as general as possible in the area classification, and more specifically, in the sub-area classification, uncovering the subject in practice.

5.2 The country of application

This classification refers to the country where the project using SODA was applied. It is worth noting that this research did not focus on the country of publication of the article. It may be possible that the authors of the articles or, even the origin of the journal do not share the same location of application in fact. In today's global context, there are researchers, consultants and students who conduct joint research, even whilst located in different countries. By knowing the country where the practice of SODA was performed, we could identify centres of research and interest in SODA. When this information was not recorded (and whenever possible), we contacted the correspondent author to request such data.

5.3 The level of application

This classification refers to the use of SODA methodology in two possible ways:

(a) As a **pure action-oriented approach**: in this case, SODA was employed as a complete, independent and sufficient technique to promote change in each specific application, even while not using (or by use of) all elements of the methodology.

(b) As part of a **hybrid (combined) approach**: in this case, SODA was associated with other methodologies in order to supplement or to enhance the other. This is also known as *multimethodology* (of partitioned methodologies) or *combination* (of whole methodologies) (Mingers & Brocklesby, 1997) or *mixing methods* (Howick & Ackermann, 2011), regardless the label or terminology, when they are linked together, entailing more than one method or parts of several methodologies in combination, creating a design specific to a particular problematic situation (Rosenhead & Mingers, 2001).

5.4 The activities used during the application

Using the framework depicted in Figure 1, we checked each article to determine which of the three activities involved in SODA are followed:

(i) *Modelling* the problematic situation: in this case, SODA was used to promote a comprehensive appreciation of the situation. This included direct consultation with those involved with the problem. This was in addition to available documents and reports when dealing with stealth problems or inaccessible persons.

(ii) *Providing a common understanding* to participants: in this case, SODA was acting as a learning approach about participants themselves, the others' worldviews and the organizations/institutions in question, thereby, establishing and increasing a knowledgebase about the context.

(iii) *Supporting group negotiation* in developing strategies and options: in this case, SODA methodology facilitated strategic debate and promoted active understanding, towards a consensual view of strategic actions.

5.5 The SODA perspectives used during the application

SODA proposes a framework for designing problem solving, in addition to a set of guidance techniques and tools for:

(i) *The Individual*: SODA methodology works directly with the individuals involved in the problem where each personal subjective view of the 'real' problem is explored. Approaching one-to-one through interviews is a fundamental element of SODA that was checked. It looks obvious that this categorization would be fully accomplished in the case studies. However, we expected to find cognitive maps being constructed from coding of written documents or from remote experts (Eden & Ackermann, 2004). In some cases, it was due to any decision or limitation, where a *focus group* was directly approached instead of each member of the problem-solving team as originally intended (Bryant & Chin, 2000). We decided to consider this 'individual' contact as a valid item. This is of great importance, since we believe that even in small groups with common interests, group members also have individual concerns and perceptions of the problem (Abuabara, Belderrain, & Paucar-Caceres, 2017).

(ii) *The Cognitive Map*: This is the facilitating device of SODA methodology which manages the messiness of deciding on action. Thus, drawing up a cognitive map (in order to organize the information provided from individuals) was the second element checked. In this classification, we considered as valid cases those using any kind of cognitive map from

individuals; from groups; from written material. This was regardless of whether it was built from concepts or constructs.

(iii) *The Bipolar Constructs*: the use of *bipolar constructs* which are the client's concepts that are separated by three dots from its *psychological opposite* (Eden & Sims, 1981) was just considered as valid. It can also be represented by a small clarification of the concept and is called bipolarity (or opposite pole). That was verified by checking any cognitive map in the article or indications presented throughout the text of the article.

(iv) *The SODA Workshop*: During SODA consulting practice, a workshop using an aggregated group map for discussion and identification of opportunities, negotiating the effective problem-solving is foreseen. Thus, the fourth element was verified through the happening (or not) of such workshop. This is even in cases where SODA is the single approach used and, the complete SODA methodology is expected to be employed. Even so, some cases may occur where the workshop may be skipped for any reason or limitation. This being replaced by a detailed structural analysis of cognitive maps, in order to find the plan of strategies, options and to conclude the case.

After the process explained above, in the following section we discuss the findings and provide an overview of SODA practice during the period of the study.

6. Discussion of Results

In this section we discuss the results of our survey and its and categorisation under the five dimensions outlined in the previous section. We start the section with an overview of the distribution of the 200 articles by year before discussing the results of the survey under: (i) areas and sectors of applications; (ii) country, (iii) level of application, (iv) activities used during the application and (iv) SODA perspectives used during the application.

An overview of the distribution of articles by year of publication is shown in Figure 3 and the average levels in three sequential periods forming a 'ladder' in ascending order. As can be seen, there is a growing interest and associated use of SODA and cognitive mapping, notably over the last two decades.
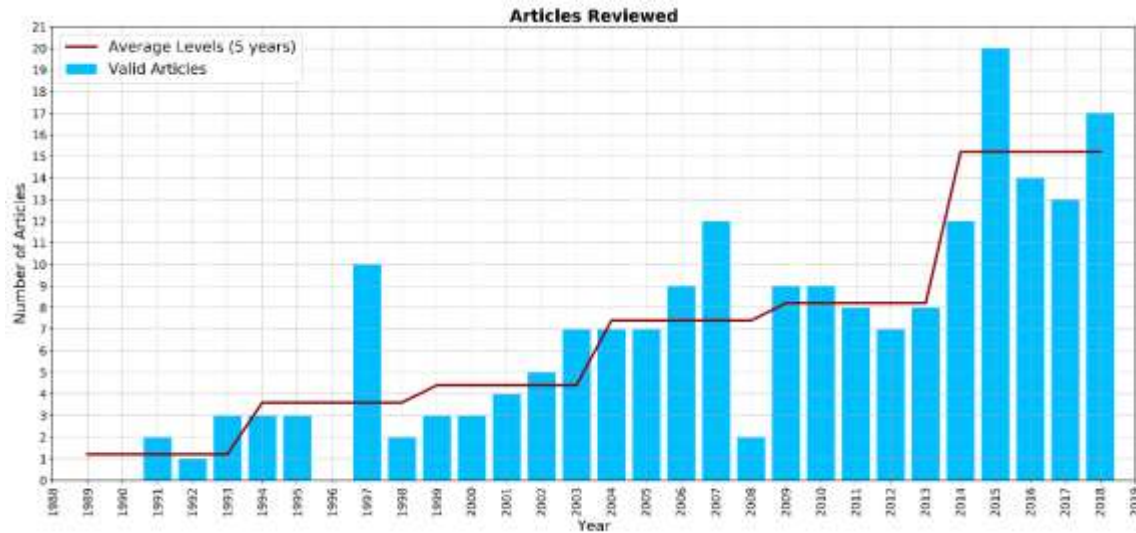
Figure 3: Articles reviewed by year of publication and levels per period

6.1 SODA's areas and sectors of applications

Over the last decades, SODA (either partially or entirely) has been applied in a vast area of interests. Table 1 details the 32 different areas that were inductively classified during the careful and full reading process of each article and, that can be merged into 11 main topics.

Table 1: SODA application areas

Area	Number of Articles		% of Area
Strategic Management	37	37	18.5
Sustainable Development	29	32	16.0
Environment Management	3		
Healthcare Management	7	10	5.0
Sport Management	1		
Quality of Life Assessment	2		
Urban Planning	3	10	5.0
Transport Development	4		
Real Estate Investment	2		
Property Management	1		
Public Management	3	13	6.5
Social & Economic Development	5		
Security Improvement	1		
Entrepreneurship Development	4		
Information Systems	17	17	8.5
Education Management	12	13	6.5
Academic Competitiveness	1		

Area	Number of Articles		% of Area
Organizational Management	9		
Knowledge Management	7		
Project Management	8		
Risk Management	6	36	18.0
Product Development	2		
Quality Management	2		
Supply-Chain Management	2		
Performance Appraisal	16	19	9.5
Professional's Performance	3		
System Engineering	3	4	2.0
Operational Reliability	1		
Others	-		
Consumer Preferences Assessment	4		
Budgetary Decisions	2	9	4.5
Litigation Claim	2		
Personal Issue	1		
Total		**200**	**100.0**

Judging by the articles surveyed, SODA applications are present in many sectors. From *agriculture* (Elsawah, Guillaume, Filatova, Rook, & Jakeman, 2015; Tröger, Lelea, Hensel, & Kaufmann, 2018) to *airline catering services* (Smart & Dudas, 2007); from *primary schools* (Sørensen & Vidal, 2002) to PhDs degrees (Tegarden & Sheetz, 2001); from the extractive sector (Poplawska, Labib, & Reed, 2017) to financial services (Ferreira, Santos, Rodrigues, & Spahr, 2014); from foundry (Swan, 1995) to wind energy (Upham & Perez, 2015); SODA and cognitive mapping have been addressing problematic situations in a wide spectrum of sectors.

6.2 The country of Application: SODA applications around the world

By surveying the locations where the case studies were conducted, it was also possible to identify the geographical centres of SODA academic research and consulting practice. This is simply because the researched object is usually close to the researcher. Hence, Table 2 shows the number of case studies according to country and respective region of application of SODA methodology. This is in absolute numbers and percentages. In some of the articles, the country where the application took place was not revealed throughout the text. However, whenever it was possible, we contacted the author(s) to find out this information. In most of the cases, the author(s) kindly and quickly responded to us. This was even in relation to articles published in the early years of the timeframe of analysis. The studies involving several countries were classified by region only. When not answered or not available, this information was classified as 'n/a' (not available).

Table 2: Number of SODA applications per region and country.

Region	Country	Number of articles per country	% of articles per country	Number of articles per region	% of articles per region
Africa	Ghana	1	0.5	6	3.0
	Tunisia	4	2.0		
	Uganda	1	0.5		
Asia	China	1	0.5	21	10.5
	Hong Kong	1	0.5		
	India	1	0.5		
	Japan	1	0.5		
	Malaysia	5	2.5		
	Singapore	1	0.5		
	South Korea	4	2.0		
	Taiwan	1	0.5		
	Turkey	5	2.5		
	Vietnam	1	0.5		
Europe	Austria	1	0.5	114	57.0
	Denmark	3	1.5		
	Finland	5	2.5		
	France	4	2.0		
	Greece	3	1.5		
	Italy	10	5.0		
	Norway	2	1.0		
	Portugal	31	15.5		
	Romania	1	0.5		
	Spain	2	1.0		
	Sweden	2	1.0		
	The Netherlands	5	2.5		
	UK	40	20.0		
	N/A*	5	2.5		
North America	Canada	7	3.5	19	9.5
	Mexico	1	0.5		
	USA	11	5.5		
Oceania	Australia	4	2.0	6	3.0
	New Zealand	2	1.0		
South America	**Brazil**	13	6.5	16	8.0
	Colombia	1	0.5		
	Ecuador	1	0.5		
	Peru	1	0.5		
SUBTOTAL		**182**	**91.0**	**182**	**91.0**
Others	N/A*	15	7.5	18	9.0
	Several Regions	3	1.5		
TOTAL		**200**	**100**	**200**	**100**

(*) N/A: information not available

The classification presented confirms thirty years of SODA practice. Ackermann (2019) commenting on the lack of Soft OR/PSM courses available suggested that the UK and Australia are the only

countries interested in the type of modelling proposed by soft OR/PSMs. Our findings are a bit more hopeful in that, SODA applications took place in five countries:

1st. **United Kingdom** (20%). The cradle of the alternative 'soft' OR paradigm and therefore, the origin of the PSMs. This finding was both expected and confirmed.

2nd. **Portugal** (15.5%). Interestingly, the number of works carried out has grown in Portugal. This is a very recent fact since about a third of the Portuguese cases were published in 2018; and the first article dates from the year 2000.

3rd. **Brazil** (6.5%). Very similar to the Portugal case but initially on a more reserved scale and, a little late. This is especially because the first Brazilian case was published in 2007. Now annually (and on a regular basis) new articles are being produced.

4th. **USA** (5.5%): This looks like a rather unlikely outcome. In contrast to the UK, the American OR approach is strongly grounded in the traditional, classical and 'hard' paradigm. In order to have an accurate analysis of this outcome we need to disassociate case studies performed within the American contexts from case studies published in the American journals. In relation to the second, that was not the focus of this study. However, we can state that overall; it appears that the writing is spread across a range of different journals (especially the European ones). We found three articles published in Omega, the US editorial-based journal. From these only one (Tegarden & Sheetz, 2003) can be counted as application to an US context; the other two (Franco & Lord, 2011; Eden C. , 1993) report cases related to British contexts. This result confirms Mingers' argument (2011) that the most important American OR journals do not publish articles related to PSMs. However, our research confirms that in recent years, this subject is not as 'invisible' and it looks likely that American researchers are starting to venture outside the OR comfort zone (Mingers J. , 2009; Dietrich, 2007). Indeed, some researchers are using SODA and cognitive mapping for modelling and providing a common understanding of the problematic situation in American contexts and publishing these cases out there. This is especially in cases reporting applications in which SODA is used in combination with other methodologies.

5th. **Italy** (5%): Italy follows the same path as Portugal and Brazil as a new 'entrant' with articles published most recently, from 2006.

The remaining (47.5%) includes another 30 countries. In terms of regions, Europe accounts for 57%.

6.3 SODA and the levels of application

By understanding SODA application levels, we were able to evaluate if practitioners are using it in its pure form as an **action-oriented methodology** or just for supporting and leveraging other methods.

With respect to the **hybrid use**, it was not our intention to evaluate the most used combinations. It is worth mentioning the work of Marttunen, Lienert and Belton (2017) that assessed the combination of

several PSMs (including cognitive/causal map and SODA) in relation to several *Multi-Criteria Decision Analysis* (MCDA) methods. Among those in our list are: *Analytic Hierarchy Process* (AHP), *Analytic Network Process* (ANP) and, *Measuring Attractiveness by a Categorical Based Evaluation Technique* (MACBETH). They concluded that the combination enriches the perspective of the decision situation. Furthermore, in the case of SODA and cognitive mapping, they facilitated development of comprehensive indicators (qualitative factors) for decision-making frameworks that included MCDA tools. Howick and Ackermann (2011) evaluated published case studies (from 1997 to 2008) that used mixing OR tools / techniques / methods / methodologies and/or paradigms. From this study, some interesting generic lessons could be taken: (i) the scope is increasing thus, it is a worthwhile area for future exploration and development; (ii) most of the mixing is practice oriented; (iii) the combinations depend mainly on the facilitators/modellers' skills; and (iv) mixing qualitative and quantitative methods in general encompass more than one facilitator/modeller, each one contributing with his/her individual expertise, contributing to the multidisciplinarity. The present study corroborates at least these first two.

As we can see, this is not an isolated case. By combining results from the next two sections (*elements* and *activities* most frequently used); we were able to have a general overview of the scene in which SODA performs better. In terms of changes over time, the hybrid use of the methodology has been increasingly frequent and stands out in relation to the use of SODA as a pure action research approach. This assertion is confirmed by Figure 6, which shows how this relationship occurs over each 10-year period. After all, unravelling real-world problems situations are inevitably multidimensional, involving material, economic, social, political, personal aspects, among other issues.
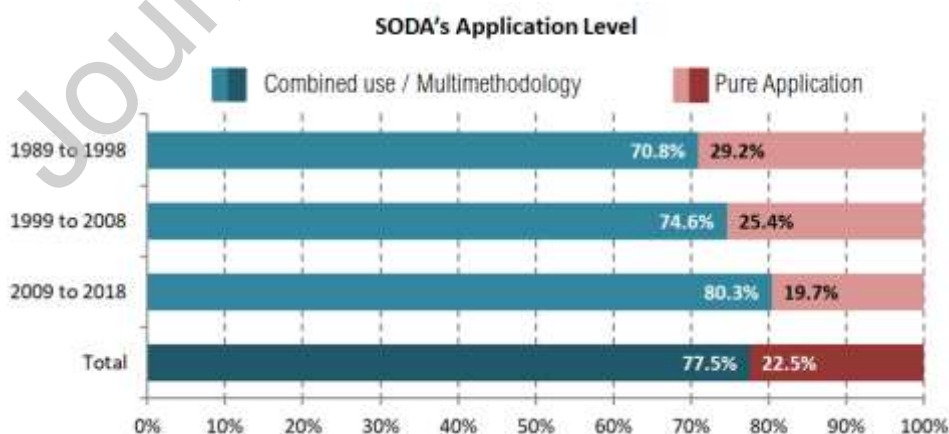

Figure 6: Levels of SODA's application.

6.4 Applications of SODA activities

The result in relation to the three activities that are part of SODA methodology will be assessed here at Figure 7. According to this, we can surmise that SODA methodology is mainly destined for *(i) modelling* and *(ii) providing common understanding of the problematic situations*. A total of 89% and 91.5% (respectively) of the cases analysed used SODA or its associated technique of the Cognitive Map for both such activities.
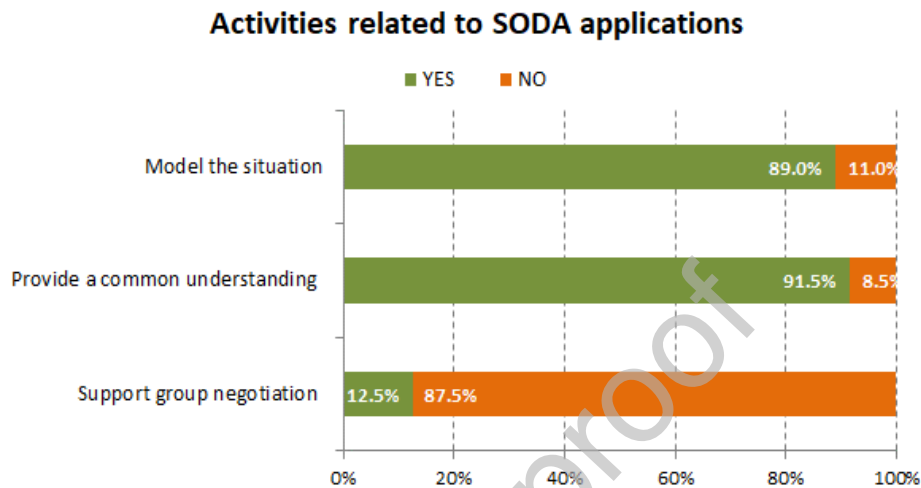
Activities related to SODA applications

■ YES   ■ NO

Model the situation		89.0% 11.0%
Provide a common understanding		91.5% 8.5%
Support group negotiation	12.5% 87.5%	

0%   20%   40%   60%   80%   100%

Figure 7: Using SODA's activities.

Although essential to the methodology, in 11% of cases, the activity of 'modelling the situation' was not explored. This means that the people involved in the problematic situation or the documents directly related to the case were not thoroughly assessed. In such instances, *what was the source of information that replace this activity?* In our survey, we found out that some other techniques replaced this activity, for instance: predefining concepts and themes extracted from the literature review of journals (Robson & Kant, 2009; Robson, 2014; Lee & Lee, 2003; Marín-Idárraga, González, & Medina, 2016); a fixed list of concepts generating a 'concept dictionary' (Massey, Clapper, & Blue, 1997); and, 'nomothetic' (instead of 'ideographic') methods allowing the selection from a predefined set of concepts (Goodhew, Cammock, & Hamilton, 2005).

Second, in practical terms, the activity 'providing a common understanding' means to merge the individual maps, direct construction of a group map, or any other way of agreeing in a collective map. One valid question would be about the 8.5% of the cases where there was no common understanding - w*hat exactly happened?* The answer varies on a case-by-case basis. Sacchelli, Fabbrizzi, *et al.* (2017) claimed to have collected data from 40 face-to-face interviews that directly fed another technique. A series of other studies performed individual maps with unit sampling and (apparently) merging was not an issue (Durif, Geay, & Graf, 2013). This is documented as well in two of the three cases reported in Pinch, Sunley & Macmillen (2010). Along similar lines to the latter study, Pitt & Sims

(1998) aimed to evaluate individual experiences (from a personal development perspective) and therefore, evaluated the maps of each individual interviewed (or of the pairs interviewed together). However, they did not escape from a general comparison and analysis of the constructs as a whole.

Finally, in relation to the activity 'support group negotiation'. It was only in **12.5%** of the cases this activity was part of the process. We suggest two main reasons that may explain such an outcome. The first is related to the use of structural analysis of the cognitive maps for evaluating the strategic options. The structural analysis especially from graph theory offers elements of quantitative analysis that seem to complement the evaluation of the implementation with SODA (Georgiou, 2009) and Montibeller and Belton (2006) reviewed the different approaches for analysis of decision options in conjunction with the use of causal maps. The second reason is that SODA seems to be apt to be used in combination with other techniques from the hard end of the OR spectrum, techniques that are analytically and driven by the search for more quantifiable results analytical method (such as MCDA) neglecting the soft, negotiating elements of SODA.

An additional possible reason behind the missing workshops in the papers surveyed may be related to the inability of certain academics to get 'clients' who are accustomed to working with groups. It seems that, OR academics may not have the skills or confidence to be facilitators in the use of PSMs. Most of the successful cases of PSMs such as SSM and SODA have been reported emphasise the importance of role of facilitators when using these methodologies (Franco L. A., 2006; Franco & Meadows, 2007; Eden & Ackermann, 2006; Mingers & Rosenhead, 2003). This is line with what Ackermann, Eden and Brown (2009) states in that a facilitator of PSM shall be more interested in working face-to-face with groups in a social process rather than in research and analysis of the problem characteristics. This is something that it is missing in all PSMs interventions. In other words, some experienced facilitators did certainly follow all SODA process whereas other less confident might just do the bits they feel confident with and left the negotiating elements undone.

6.5 The SODA perspectives used during the application

Figure 8 presents the result of the four elements (Individual inquiry, Cognitive mapping, Bi-polar constructs and SODA workshop) evaluated in SODA applications. In the next sections, the findings on the use of these elements are discussed.
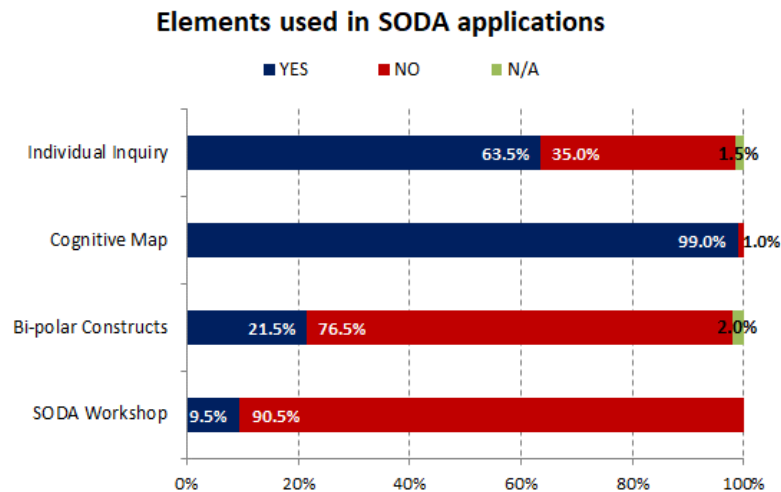
Elements used in SODA applications

■ YES ■ NO ■ N/A

Individual Inquiry	63.5% 35.0%	1.5%
Cognitive Map	99.0%	1.0%
Bi-polar Constructs	21.5% 76.5%	2.0%
SODA Workshop	9.5% 90.5%	

Figure 8: The use of SODA's elements

(i) A 63% share of reported cases adopted the **Individual Inquiry,** contradicting the argument that the significant time demanded in individual maps is a barrier and consequently it is being replaced by group causal maps (Eden & Ackermann, 2018). This figure also included the studies that used a mixed approach, for instance individually and in groups as happened with Koukouris (1991), who combined individual interviews with small groups' interviews. The 35% share performed the data elicitation from any source other than the individual: group work (Bryant & Chin, 2000), any written material such as company's annual reports (Midttun, Dirdal, Gautesen, Omland, & Wenstøp, 2007) or even review of literature (Sarkis, 2014). The methodology is flexible enough to accept any of these options and, the choice for one or the other approach (or a blend of them) will depend on certain conditions such as; access and willingness of people for participation and, available time (among others). Just 1.5% of the cases did not leave such information details during the case report, having been classified as 'not available' (N/A) information.

(ii) In relation to the **Cognitive Map**, the two-dimensional directed graph is undoubtedly the heart of the methodology. This finding is corroborated by a study conducted with members of the UK OR Society. This research concluded that within soft approaches, the 'cognitive map' technique (along with SSM) had considerable high scores as a tool for supporting strategy process (O'Brien, 2011). Very often, the label 'SODA' has been replaced by *'cognitive map as proposed by Eden & Ackermann'* (and similar references) and, become independent as it separates from the next element ('SODA workshop').

(iii) In relation to the **Bipolar Constructs** (in opposition to the *Unipolar Concepts*), we found a low use (just 21.5%) of this important element of SODA. During the careful reading of the articles,

we searched for any of Kelly's theory references or even checked in the illustrated maps/figures whether the bipolarity was present. We detected a lack of understanding and usage of this crucial SODA element. We found that this element was not being used in the way SODA's creators intended: According to Eden (2004):

> *Cognitive maps are not simply 'word and arrow' diagrams, or influence diagrams (as used by system dynamicists [...]), or a 'mind-map'/'brain-map' [...]. Mapping processes often lead to the later development of influence diagrams as a lead in to system dynamics simulation modelling [...]. Cognitive mapping is a formal modelling technique with rules for its development. The formal basis for cognitive maps derives from personal construct theory* (Kelly, 1955).

This practice of not using the bipolarity mode has been already pointed out in recent studies (Georgiou, 2012; 2011). This is corroborated by our survey in which we noted that a number of cases in which researchers have not regarded perceptions and meanings through bipolar constructs and sometimes using just words/concepts and arrows. As a result, the cognitive map proposed becomes a simple concept map (not even a causal map with clear means-ends relationships).

Furthermore, regardless whether a conceptual or a cognitive map, Eden & Ackermann (2018) argue that the map shall be used as a transitional object for cognitive and social negotiation among the management team; our study shows that from the articles surveyed there has been a lack of understanding of this SODA feature as stated by its originators. This is corroborated with what Eden stated when he detects the misuse of SODA elements caused by the lack of rigour in the PSM teaching:

> *I personally have seen "cognitive maps" that bear no resemblance to the maps I would produce (which follow clearly articulated guidelines).* (Ackermann, 2019)

(iv) The majority of cases (90.5%) did not use a **SODA Workshop** (group negotiation) as foreseen in the third activity in Figure 1. This sits in line with to the portion of cases that did not use 'support group negotiation' (87.5%), as evaluated in the previous section. This result can be expected due to the fact that this *element* is closely related to that *activity*. Furthermore, the difference between the two figures (percentages) can be associated with the use of other methods of supporting the group discussion. For instance, this is seen in the following cases: Brännback, Tetard & Beijar (1997); Goodier, Austin, *et al.*, (2010); and Mackenzie, Pidd, *et al.*, (2006). For more examples see full list of SODA application in Appendix 1.

One alternative for not using the SODA workshop is to explore the structural analysis of the collective cognitive maps in order to plan strategic options. After all, as remarked by Georgiou (2011); *"SODA is a cognitive mapping approach whose qualitative content is structured in such a manner as to render it especially amenable to quantitative analysis*". This is because SODA maps are easily manageable with robust analytical tools of digraph theory. However, we argue that this option is predominantly an analytical one, as opposed to the social activity that characterized the SODA experience (Eden C. , 1993). Georgiou (2011) continues by claiming that *"Measurements, of any sort, do not provide answers in themselves, and much less should they be used as a substitute for thinking through the situation in question. Measurements are to be used in conjunction with a more holistic understanding of the map and the situation it is describing, so that informed conclusions can be drawn."* Some examples of using structural analysis (and not SODA workshop) includes: Cunha *et al.* (2016); Dias *et al.*, (2016); and, Guarnieri *et al.* (2016).

Although the visual basis (cognitive map) and language-based construction make SODA methodology a clear and easy-to-understand approach by the participants, requiring little prior training (Georgiou, 2011), organizing people in a SODA workshop seems to be a real challenge. Physical and schedule-related excuses are initial constraints (*e.g.* people from different organizations or departments). However, one of the most relevant features for a useful intervention process is the willingness and engagement of the participants to work together. This is necessary in order to debate openly towards a commitment that harmonizes all concerns, even if this can be a source of possibly conflicting and emotionally draining activity. It leads us to believe that there can be particular groups of clients who are more (or less) prone to the participatory processes that a problem structuring method such as SODA entails. In other cases, usage of other methods (*e.g.* quantitative ones) might prove to be suitable, in which the PSMs play a complementary role.

7. Conclusions

About 40 years ago, cognitive mapping as a concept was introduced to the MS/OR field. Later on, it developed into a structured methodology: Strategic Option Development and Analysis (SODA), an OR originated approach that, together with SSM and SCA, has become a well-used methodology for supporting problem structuring and decision-making in complex situations. In this article, we surveyed relevant databases, studied in depth 200 articles and confirmed the increasing usage of SODA over the last three decades (1989-2018) in many fields of knowledge around the world.

To ascertain and evaluate the usage of SODA applications, we propose a model that incorporates the four theoretical perspectives informing SODA and it can be seen as an initial attempt to create SODA

constitutive principles through its core activities and selected elements to assess the ways in which SODA was applied.

On the other hand, one of the *definitional statements* about SSM use, which by implication must be observed for the claim of SSM use to be valid were raised by Yearworth and White (2014). It is worth to repeat it here *mutatis mutandis* in relation to SODA usage:

> […] *since SSM likely to be used in different ways, interpreted differently by each user, then some conscious thought must have gone into how it was adopted for a particular situation* (p.934).

And that was certainly the case of the some articles evaluated in this paper in which their authors did claim to have used SODA or cognitive mapping (as related terms were identified in keywords search), regardless if canonically or incorrectly, partial or total, solely or combined. They were free to make their own methodological framework using the methods (or part of them) from PSMs (including SODA) available.

Although our findings suggest that SODA is a PSM that has had a steady and continuous growth over time, the study revealed that the main areas of application identified were: Strategic Management; Organizational Management and, Sustainable Development. These are within the sectors of Education & Research, Environment and, Business in general. Among the regions where SODA is practiced, our results suggest that the UK occupies the first place followed by Portugal, Brazil, USA and Italy. Although, SODA is well known and applied all over the world. In terms of region, Europe is by far the region where most applications have been taking place.

Our survey also suggests that although SODA offers 'stages' of logical processes that are recommended to be followed, as the core of the methodology, and despite of the clarity in which the SODA creators have explained these stages, we found that not all those who claim to use SODA have followed these guidelines. Our findings reveal that in some cases there are inaccuracies in structuring the constructs that are being replaced by the simple unipolar concepts. Additionally, SODA's applications have presented over-dependence on the combination with other methods and techniques. This has strengthened them but limited SODA's function for a problem structuring methodology - thus, losing its fundamental role as a 'negotiating device' of strategy reflection and development.

8. Final remarks, research limitations and further research

SODA is an interactive, motivating and an extremely versatile tool for enhancing transparency and improving understanding of messy situations. It is also flexible and adaptable within each particular context where we have to accommodate the limited information that we have in hand. Our findings corroborate the flexibility and applicability of SODA as a methodology to adapt in different

circumstances and to a diverse set of problem contexts. To certain extent this success could be related to the fact that, unlike other popular PSMs, (e.g. SSM), SODA, over the decades, has developed a much more open approach and has been ready to adapt this approach to developments in OR/MS practice. In particular, to embrace technology to aid its mapping tools; the early version of SODA used COPE, and later Decision Explorer and Group Explorer as software support.

Furthermore, we have surveyed key SODA applications articles and reflected in the way they have applied the methodology, but we do not claim to have drawn the full role and legacy of SODA in the MS/OR arena. To overcome these inevitable limitations, we envisage that there are some avenues that need further development. For instance, contacting authors and practitioners we could uncover the reasons for the restrictions and limited SODA usage and to explore how satisfied are users with the methodology in their efforts to structure a problematic situation.

The findings of this study should be seen in light of some limitations. The survey sampling frame was drawn from published articles in academic journals and our finding reflect its use by academics or academic/practitioners. Not having access to the way SODA was applied by sole practitioners or consultants who do not publish is clearly a limitation. We hope to continue updating this research so we can keep track of applications of this important PSM that has proved to be very influential in the MS/OR community.

Finally, and although the survey has its limitations in terms of the scope and theoretical positioning, this article is the first attempt to survey SODA applications and highlight its importance role in the Soft OR/ Problem Structuring Methods practice environment. We also highlight the need to provide a set of the constitutive rules to guide SODA applications more effectively and discuss coherently the future use and applications of SODA in all its forthcoming developments.

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Graphical Abstract