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CROATIAN CRISIS MANAGEMENT SYSTEM'S RESPONSE TO COVID-19 PANDEMIC THROUGH THE LENS OF A SYSTEMIC RESILIENCE MODEL

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ABSTRACT

We analyse the Croatian crisis management system's response to COVID-19 pandemic in terms of Fath, Dean, and Katzmair's [1] model of resilience in social systems. We find that the Croatian crisis management system has successfully completed one cycle of the model. However, if the system is to achieve resilience, it also needs to replace the regime from before the crisis with a new regime that will simultaneously enable a life of relative normalcy and contain an excessive spread of the virus. Strengthening social cohesion and more bottom-up, emergent leadership might facilitate the search for a new regime. Small, local outbreaks represent small-scale disturbances that provide opportunities for the development of cohesion and bottom-up leadership from local, county, municipal and city-levels to the national level. The model used in this article better conveys the underlying complexity of crisis management systems than "the hammer and the dance" model, whereas the latter is better suited for public communication. Future work should extend this case study in terms of modelling approaches, the sample of countries, and the time covered. It can also be extended to lower, sub-national, as well as higher, supra-national levels, such as the EU.

KEY WORDS

COVID-19 pandemic, crisis management, societal resilience, systemic resilience, the hammer and the dance

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INTRODUCTION

Resilience, a concept understood as "the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when it must" [2; p.1034], has its roots in ecology [3] and materials science [4]. However, the concept has recently been extended to diverse scientific disciplines, such as behavioural and brain sciences [5], social psychology [6], social work [7], economics [8], sociology [9, 10], political science [11], crisis management and security issues [12-14], among others.

In this article we use a model of resilience in social systems, proposed by Fath, Dean and Katzmair [1], to analyse the Croatian crisis management system's (CCMS's) response to COVID-19 pandemic in the first half of 2020. The purpose of the analysis is to look at the CCMS's response through the lens of the model, and use the insights obtained to better understand the system's resilience and see whether it can be further improved.

By the CCMS in this article we mean, in the first place, hierarchical network of civil protection headquarters (CPHs), with the national CPH at the top level, county CPHs at the intermediate level, and municipal and city CPHs at the local level. The Croatian Government tasked the national CPH with coordinating activities related to responding to the COVID-19 pandemic in Croatia [15], and the national CPH authorised the lower-level CPHs to coordinate activities within their local areas [16]. As the CCMS cannot be separated from the rest of society, the discussion will also occasionally touch on the relations between the CCMS and the wider political, economic, and civil society spheres.

This research effort is a case study which can be extended toward a more comprehensive comparative research framework, as outlined in the concluding section. The main reason why we chose Fath, Dean and Katzmair's model as a tool for analysis is the balance between simplicity and complexity that seems to be just right for an initial case study. In particular, we shall show later that this model is more complex than another often cited model addressing issues related to the COVID-19 pandemic – "the hammer and the dance model". Yet, the model we use is simpler than other systemic resilience approaches, such as ecological information-based networks and models using statistical evidence of resilience [17]. As noted in the concluding section, we may try some of the more complex models in future research.

The article is structured as follows. In the next section, we briefly describe Fath, Dean and Katzmair's model of systemic resilience. Then we analyse CCMS's response to COVID-19 pandemic in terms of the model. We particularly discuss implications of the analysis for resilience of the CCMS, social cohesion, leadership, candidates for the measure of strain on resources in the model, the role of small-scale disturbances, and the comparison of Fath, Dean and Katzmair's model with "the hammer and the dance" model. We conclude by recapitulating the main findings, spelling out their policy implications, and outlining possible extensions of our analysis.

THE MODEL OF RESILIENCE IN SOCIAL SYSTEMS

The model of resilience in social systems, described by Fath, Dean and Katzmair [1], is an extension of previous models developed in the field of ecology by Holling [18], and Burkhard, Fath and Müller [19]. The model is based upon the "panarchy approach" [20-22], which conceptualises the resilience of a system as a two-dimensional adaptive cycle. Degree of system's institutionalisation, which reflects flexibility or rigidity of the system, is represented by the abscissa, while the system's resources, which reflect the systems adaptive potential for change, are represented by the ordinate [17].

The system is imagined to cycle along a trajectory in the shape of a tilted figure "8" (Fig. 1). Each cycle consists of four stages: *r* – new beginning and growth; *K* – equilibrium, conservation and *status quo ante*; Ω – dissolution and confusion; and α – reorganisation and innovation. The *r*-stage is mainly concerned with the instauration of the new and abolishment of the old; the *K*-stage is about controlled development and maintenance of system function; the main concern in the Ω-stage is survival; while the α-stage is about renewal, regeneration and reorientation [1]. Additionally, the *r*- and *K*-stages are characterised by many small-scale cycles – sub-trajectories "representing modular experimentation within the overall upward system trajectory" [1; p.2]. These small-scale cycles are visually represented by many small loops in the shape of figure "8" (Fig. 1).

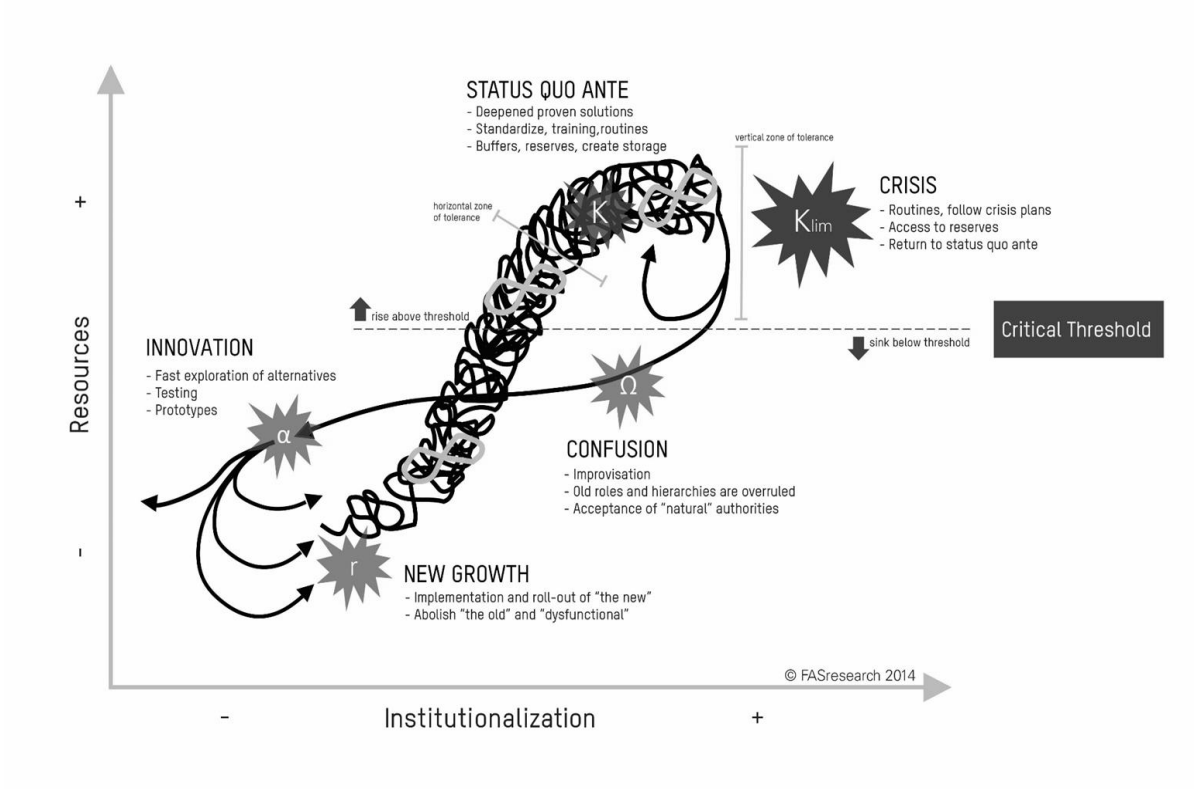

Figure 1. The model of resilience in social systems [1].

Each of the stages is also associated with its corresponding "trap" that endangers the system's cycling. The main trap of the *r*-stage is the "poverty trap", which "occurs when a system cannot access enough activation energy to reach a state where positive feedbacks drive growth internally" [1; p.2].

The trap of the *K*-stage is the "rigidity trap", wherein "a system becomes so refined in its processes that there is little room for further innovation" [1; p.3]. The rigid system becomes brittle and vulnerable to disturbances. Additionally, there is a critical threshold K_{lim} associated with this stage (Fig. 1). The systems that sink below this threshold are able to persist through a crisis. The systems that continue to "overshoot" the threshold K_{lim} presumably continue within the *K*-stage until the next crisis, at the expense of getting too big and brittle making surviving Ω-stage less likely. Such systems are deemed to engage in a "relentless resource acquisition" [1; p.4] and excessive spending, leading to a danger of overstretch.

The trap of the Ω -stage is the "dissolution trap", manifested in an inability of the system to survive the omnipresent confusion. Finally, inability to reorient the system in the α-stage leads to the "vagabond trap", i.e. "circling compassless, without moving into the *r*-stage of growth" [1; p.4].

Fath, Dean and Katzmair claim that "resilience is linked to some dynamic between slow variables that represent the underlying structure of the system and fast variables that reflect dynamics in the present" [1; p.6]. They further hypothesise that, in social systems, social cohesion is the key factor that "represents the interplay between fast and slow variables" [1; p.6]. Another important factor are small-scale disturbances in the *K*-stage, which "should be encouraged (…) because they contribute to the adaptive capacity of the system and its ability to innovate" [1; p.7].

Finally, Fath, Dean and Katzmair propose that a resilient system "is one that is able to navigate successfully through each stage of the cycle, adopts a new regime that shares important features of the previous regime, and continues to satisfy a set of goals as defined by members within that organization" [1; p.8].

CCMS'S RESPONSE TO COVID-19 PANDEMIC IN TERMS OF THE MODEL

***K*-Stage** Prompted by the spread of COVID-19 pandemic in China, the Croatian Government started taking preparatory measures in January 2020. On 13 February, the Government established the national Civil Protection Headquarters (CPH) to coordinate all services involved in prevention of the COVID-19 pandemic in Croatia [15]. However, public interest in all these activities was relatively low and the pandemic was generally not perceived in public as a serious threat at the time. The national crisis management system was yet not under stress and it continued to operate as usual. Hence, we can safely assume that, in terms of the previously described model, the system was in the pre-COVID *K*-stage, aptly described as *status quo ante*.

CYCLE 1

Ω-Stage The situation suddenly changed on 25 February, when the first case of COVID-19 infection in Croatia was confirmed and the number of new cases[1] started to rise slowly but steadily in the following days [23] (Fig. 2). Public opinion changed swiftly. Fear and even panic started to rise [24]. Shelves in supermarkets were emptied rapidly, which urged the Prime Minister to calm the public down [25]. Despite the appeals, the strain on some resources was considerable. In particular, there were shortages of face masks and disinfectants.

The CPH started its daily sessions after which press releases were issued [15, 26]. On 5 March the Minister of Health declared the danger of COVID-19 epidemic in the whole Republic of Croatia [15]. The CPH and the Ministry of Health introduced several packages of measures, mostly related to crossing the state borders, international travels, and rules of procedure for healthcare professionals [15]. All kindergartens, schools, and universities were closed on 16 March, and classes were continued remotely via television and online platforms [27]. On 19 March the CPH introduced one of its most comprehensive sets of measures that included "suspension of social gatherings for more than 5 persons; suspension of all cultural activities; suspension of the work of cafes, bars and restaurants (except delivery), as well as of services that include direct contact with clients (hairdressers, beauticians, barbers, pedicures, massage parlours, saunas, swimming pools); suspension of all organised sports activities and contests; suspension of all workshops and courses; suspension of religious gatherings" [28; p.3]. Fearing that existing hospital capacities might not be enough, the CPH authorised setting up provisional hospitals in sports halls and large military tents [29].

The main question that public health decision-makers were grappling with was: "What's next?" [30]. And, next came an earthquake of 5,5 magnitude on the Richter scale that struck the Croatian capital of Zagreb on 22 March, leaving one person dead, 26 injured, and more than 26 000 houses damaged, 1900 of which were inhabitable [31-33]. The Ω-stage of

confusion reached its apex. On 23 March, the CPH restricted free movement. Citizens were prohibited to leave their city or municipality of residence, except with special permissions [34]. Although, as we already remarked, various restrictive measures had been brought into force even earlier, it was 23 March which in everyday parlance became known as "the beginning of lockdown" [2].

α-Stage Having most measures in place, the main task for the CPH in the ensuing period became fine-tuning of the measures. Indeed, "[t] he success of navigating through the fast-moving α-stage is largely a function of system development and decisions made in prior stages" [1; p.4]. The fine-tuning required careful monitoring and evaluation of measures' implementation. Some of the measures proved to be overly restrictive and required relaxation. For example, although green markets were closed on 22 March, they were reopened, under a special regime of operation, as soon as on 8 April [35], as it became evident that they do not pose danger to public health and that it would be wasteful to let large supplies of fresh and healthy food perish. Similarly, the model of organised convoys for transiting freight vehicles was abandoned as soon as it became evident that it was overly restrictive [36]. Some measures, on the other hand, were strengthened. For example, permissions to travel between cities, municipalities and counties were found to be often misused, so the system of their issuing was streamlined, and their maximum validity period shortened from 30 to 14 days [37].

Although the leadership was mainly top-down – from the national to regional and other local levels – there were also examples of bottom-up initiatives. For instance, quarantines were introduced at the initiative of some local communities, such as Murter and Betina, where outbreaks were particularly severe [38]. Some local self-government units decided to close promenades and walkways for fears of outbreaks at such places [39].

Although the economic sphere is not at the focus of this article, we need to emphasise that most of reorganisation and innovation, predominantly but not only in the α-stage, took place in businesses, particularly small ones. Many small agricultural producers were, for example, forced to start selling their products online, as this proved to be the only way to find customers, under the lockdown [40]. As one commentator observed, "one small light in the coronavirus pandemic is that it has forced creativity in order to sustain businesses, and Croatian farms that formerly only had a presence at their market stands now belong to large online communities" [41]. Again there were examples of emergent bottom-up leadership, as some local self-government units, such as the City of Križevci, helped small agricultural producers to establish a web-platform over which they could offer their products and services to a wide range of customers [42].

There were fears that the Zagreb earthquake "would accelerate the spread of the COVID-19 epidemic in Croatia since the earthquake (…) triggered migrations to other parts of the country" [31; p.2]. There were also fears that natural human need for social support in times of distress would overrule restraint and physical distancing needed to prevent the spread of the virus. Fortunately, such fears remained unsubstantiated as there was no significant increase in new cases of disease in the earthquake's aftermath [31].

After reaching the peak of 96 on 1 April, daily number of new cases in Croatia started to decrease (Fig. 2). By 22 April, 5-days moving average of daily new cases dropped to around 30, and it was estimated that the reproduction number R – the expected number of additional cases that one case will generate in a population, on average, over the course of its infectious period [43] – dropped to approximately 0,8. It was also claimed that it had been below or around 1,0 for weeks already [44]. When R is below 1,0, it indicates that the number of cases is decreasing, meaning that the spread of the virus is effectively contained. On 23 April the Government announced gradual relaxation of restrictions in three phases [45].

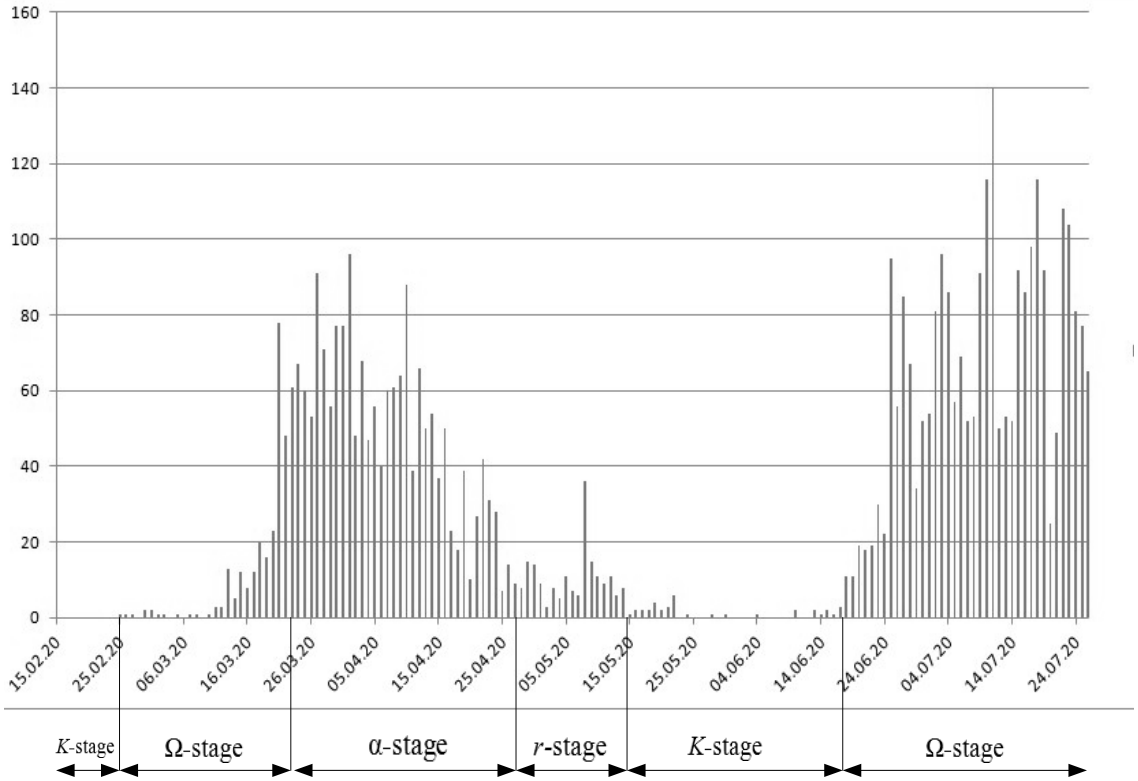

Figure 2. Daily new cases of COVID-19 in Croatia by stages. The data on daily numbers of new cases in Croatia were collected by the authors from public sources, whenever possible from press releases of the CPH.

***r*-Stage** The "new beginning" started on 27 April with the reopening of most retail stores, services, public transport facilities, libraries, museums, and galleries [45]. By the middle of May, 5-days moving average of daily new cases dropped below 10 (Fig. 2) and most of the measures were lifted.

***K*-Stage** For a monthly period between mid-May and mid-June, the number of daily new cases remained below 5, the only minor exception being 22 May, when 6 new cases were recorded (Fig. 2). General public perception was that the danger is over and that life might go back to normal. Official recommendations related to keeping physical distance and using disinfectants were still in place, but most of the people, particularly younger ones, stopped following these advices. During this period, the authors of this article several times found hygiene stands with disinfectants in public places, such as shops, being emptied rather than full, and nobody seemed to care about it. Citizens were supposed to adapt to a new regime of co-existence with the virus or "the new normal", but they returned to "the old normal", the *status quo ante* in the literal sense. It was as if the success of the lockdown lulled them into a false sense of security.

It would be wrong, however, to blame only ordinary people for such a state of affairs. The CMS, headed by the CPH, was not pro-active enough in its advisory and educational roles. Two additional factors were involved in complicating the situation. First, tourist season, which in Croatia reaches its highest points in July and August, was approaching, and it was widely viewed as a chance to compensate for at least some of the economic losses incurred by the lockdown. It was also believed that too much talk about COVID-19 dangers in public could spoil this chance. And second, parliamentary elections were scheduled for 5 July, and it was again deemed inappropriate to remind the population of COVID-19 dangers prior to the national "festival of democracy". Taking it all together, it is not surprising that the new increase in cases of COVID-19 infection caught everyone somewhat off-guard.

CYCLE 2

There is some uncertainty as to whether an increase in the number of new cases of COVID-19 infection in Croatia in the second half of June reflects a continuation of the first wave or the beginning of the second wave. According to the epidemiologist Bernard Kaić, this question is of only a limited importance [46]. We decided to call this new increase a "second cycle", as it indeed corresponds to a second loop along the system's adaptive trajectory.

Ω-Stage The number of new cases started to rise again in mid-June (Fig. 2). On 3 July, the maximum of 96 from the first cycle was achieved again, and on 11 July, the new maximum of 140 was recorded. The total number of cases grew from around 2 250 after the first cycle to around 4 000 in mid-July. The authorities made it clear that there will be no lockdown anymore because of its destructive economic consequences [47]. However, the CPH had to introduce some measures again. For example, face masks were made mandatory in numerous indoor settings, such as public transport, shops, banks, post offices, and various other services [48]. At the time of this writing, the question of what's next becomes all the more prominent once again. Summer does not seem to have diminished the virus' strength as was expected, and the worries of what the autumn flu season may bring have only intensified.

DISCUSSION

RESILIENCE

When the number of COVID-19 cases started to rise in early March, the uncertainty was also rising. The CPH and other authorities were not sure whether existing healthcare capacities will be enough and terrifying scenes from Italy served as examples of what can happen in the absence of timely and decisive action. Hence a lockdown was imposed. It was hard to bear economically and psychologically [49, 50], but it successfully curbed the spread of the pandemic. By the end of the first cycle in mid-June, Croatia had around 2 250 cases and 107 deaths in total, or around 550 cases and 26 deaths per million of inhabitants. These moderate numbers meant that most of the set-up provisional hospitals, fortunately, proved to be unnecessary.

The CCMS has successfully completed one cycle along the adaptive trajectory, avoiding all the potential traps. However, the very success of the lockdown lulled most people into thinking that the danger was over and that the return to the previous way of life was possible. A resilient system is not only the one "able to navigate successfully through each stage of the cycle", but also the one that "adopts a new regime that shares important features of the previous regime, and continues to satisfy a set of goals as defined by members within that organization" [1; p.8]. While the CCMS fulfilled the first condition, the second one is yet to be accomplished. The system has to learn to co-exist with the virus in a new regime that will simultaneously enable a life of relative normalcy *and* contain an excessive spread of the virus. One of the most delicate tasks will be balancing between reasonable interpersonal contact and avoidance of infection. The amount of public outcry that accompanied the attempts of the CPH to regulate social events such as wedding parties shows how demanding this task may prove to be [51].

SOCIAL COHESION

We concur with Fath, Dean and Katzmair's proposal [1] that social cohesion is the key factor in social systems' resilience. Indeed, there is evidence of strong social cohesion during the first cycle, and particularly in its α-stage. The majority of citizens supported measures taken by the CPH during the lockdown [52]. This, together with the success of the lockdown, fits well with Fukuyama's [53] proposal that "the thing that determines a country's resistance to the coronavirus" is "whether citizens trust their leaders, and whether those leaders preside

over a competent and effective state". Rothstein [54] explained differences in success in containing the virus between Nordic countries and Italy by higher levels of social and political trust in Nordic countries. As social cohesion includes trust [55], these findings are in agreement with the above cited Fath, Dean and Katzmair's hypothesis [1].

There were also many examples of social solidarity during the first cycle. Bad Blue Boys, an ultras group of supporters of the football club Dinamo Zagreb, assisted in preparations of the Dubrava Clinical Hospital for admission of COVID-19 patients, launched an action to help elderly, infirm, and chronically ill fellow citizens who needed assistance during the pandemic, and were among the first to help the Maternity Hospital in Petrova Street after the Zagreb earthquake, rescuing pregnant women from damaged buildings and carrying new-borns in incubators to safer hospitals [56, 57]. Thousands of volunteers, including those organised in a Facebook group "People for other people"[3], offered to provide aid to elderly and other people in need during the lockdown [28]. Some commercial web portals offered free-of-charge promotion to small businesses that were delivering food and other necessities [58]. Many small businesses were delivering food free-of-charge to exhausted healthcare workers. In cities, people were coming out at their balconies, singing, clapping hands, and cheering in expressions of mutual support and solidarity with professions who were bearing the brunt of the COVID-19 crisis.

However, as the first cycle was subsiding, there were less such displays of social cohesion, and polarisation of society became particularly apparent prior to the parliamentary elections. Political rallies replaced all-together chanting from the balconies. Allegiance of members of the CPH to the ruling party likely contributed to the lowering of trust in their decisions among voters of other parties. As of this writing, the President, who was elected as a candidate of the strongest opposition party, as well as several other opposition parties are questioning the constitutional status of the CPH [59]. While the legal status of this body certainly needs to be clarified, it is questionable whether the high point of the second cycle is the right time for bringing its legitimacy into question. Some observers, such as Marko Kutleša, Head of the Intensive Care Unit at the University Hospital for Infectious Diseases "Dr. Fran Mihaljević" in Zagreb, hold that many actors in this crisis, including the CPH, try to score political points and misuse the situation for public relations purposes [60]. If this is the case, then it is no wonder that social cohesion suffers. Follow-up studies can investigate more deeply the factors of social cohesion such as trust, inclusion, shared values, and strength of social relations to assess enhancing its capacity for just such crisis moments.

Weakened social cohesion may be one of the reasons why the second cycle was so intense in terms of new cases. In future research, our so far largely anecdotal evidence should be backed by more rigorous measurements [55] and/or use of aggregate indices of social cohesion [61, 62].

LEADERSHIP

We also tend to agree with Fath, Dean and Katzmair's [1] emphasis on the role of leadership in the Ω-stage. Indeed, the role of the CPH and other authorities was crucial in the Ω-stage of the first cycle, and the lack of reliable leadership has so far characterised the Ω-stage of the second cycle. This may be related to the fact that the main direction of control during the lockdown was mostly top-down – from the CPH and other authorities toward local self-government and citizenry – whereas in the second cycle the locus of responsibility shifted toward the individual level. In the latter case, the role of emergent leadership – "actors not tasked with leadership roles [who] informally assume key positions during crisis" [1; p.3] – should be crucial.

However, no clear emergent leadership appeared during the second cycle so far, although there are some promising examples. An example of bottom-up initiative emerged in the tourism sector where it was articulated that some more stringent measures, such as mandatory

face masks in indoor public spaces, would actually do more good than harm to the sector [63]. The CPH of the Istria County has been among the most active regional CPHs since the beginning of the first cycle. Depending on the local circumstances, they asked from the national CPH to strengthen or relax various measures in their county and most of their proposals were approved [64, 65]. As of this writing, the CPH of the most eastern Croatian county – the Vukovar-Syrmia County – requested from the national CPH to ban all the wedding parties in the county, except those attended by only closest family members, for at least two weeks, as wedding parties proved to be places of major outbreaks in the county so far. The national CPH accommodated their request [66]. A group of enthusiastic professors from Osijek and Slavonia is working on a proposal to include various topics on biosecurity and protection from COVID-19 in school curricula [67]. Future successes in fighting the pandemic may well depend on a shift toward more such locally instigated measures and initiatives.

THRESHOLD K_{lim}

Perhaps the most obvious candidate for K_{lim}, in the context of our application of Fath, Dean and Katzmair's model [1], is the value of the reproduction number R = 1,0. Overshooting this threshold means that the spread of the virus is not under control, and there is a danger of resource overstretch. Keeping R below 1,0, on the other hand, means that the spread of the virus is contained. The problem with R is that it is not easily calculable – its calculation requires considerable epidemiological expertise and there is a time lag in results[4]. As a quick and easy rule of thumb, the number of new cases per 100 000 inhabitants can be used. For example, the number of 10 new cases per 100 000 inhabitants in the last 14 days is used by Slovenian epidemiologists as a threshold for "epidemiologically safe countries", whereas the EU proposed a somewhat more lenient threshold of 16 [68].

Whatever the value of K_{lim} is taken to be, the major discrepancy between the original model [1] and our application is that descent below the K_{lim} threshold is in the original model deemed to happen in the K-stage, whereas in our application this occurs later, in the Ω- or even α-stage. Perhaps a clearer specification of what K is supposed to denote in the original model would help. Currently, it seems that K is some kind of a proxy for a strain on system's resources, and as such, both R and the number of new cases per 100 000 inhabitants are plausible. If we are to choose candidates for K that are determinable as early as in the K-stage, we would pick something like the number of tests conducted or the number of epidemiologists available per 100 000 inhabitants, for these seem to be crucial for early warning and prevention. Note that these parameters are inverse measures of strain on resources – generally, the higher they are, the lower the strain that can be expected in later stages. However, neither the tests nor the work of epidemiologists come for free, but more detailed considerations of cost-effectiveness of those resources are beyond the scope of this article.

SMALL-SCALE DISTURBANCES

We have already mentioned the importance that Fath, Dean and Katzmair ascribe to small-scale disturbances which "represent multi-level interactions that promote learning of the system and allow upward flows of information (…) through smaller, faster sub-systems to the larger, slower system" [1; pp.7-8]. The small-scale disturbances in our conceptualisation would be small, local outbreaks that arise in the K-stage, represented by small numbers of daily new cases between mid-May and mid-June in Figure 2. If they are successfully repressed, the chances of future major outbreaks are diminished. These small, local outbreaks can be regarded as a sort of "training" of the system for possible larger emergencies.

The "smaller, faster sub-systems" in our conceptualisation would be regional and local, i.e. county-, municipal- and city-level, CMSs, headed by local CPHs, the task of which is to monitor

the local situation, react as quickly and efficiently as possible to the local outbreaks, and stifle them [69]. We also relate these smaller sub-systems to the small-scale cycles of Figure 1.

We can "go local" even further to include individual-level behaviours and decisions – such as physical distancing, wearing face masks, using disinfectants, getting tested when ill, etc. – as even "smaller, faster sub-systems". In fact, it can be argued that this is the ultimate "local scale" which can address the problem. We also do not feel obliged to limit these small-scale cycles to the *r*- and *K*-stages only, as they seem to be present in all stages.

It is also tempting to consider how to extend this analysis in the other direction – toward supra-national levels. Indeed, it is imaginable that the big cycle from Figure 1 represents the EU level, and the smaller cycles – the level of individual member states, Croatia including. Again, we can go even further and think of the world as the ultimate systemic level, and the individual countries, or supra-national units such as the EU, as the smaller cycles.

COMPARISON WITH "THE HAMMER AND THE DANCE"

Another popular and often cited model dealing with the COVID-19 pandemic is "the hammer and the dance" [70]. In this metaphor, "the hammer" represents "quick and aggressive" [70] measures, such as lockdown, to curb the spread of the virus, lower *R* below 1,0, and buy the time needed for a full preparation of the CMS. The "hammer" is followed by the "dance" – a "months-long period between the Hammer and a vaccine or effective treatment" [70], during which a combination of less restrictive measures is applied as needed: testing, contact tracing, quarantining, isolating, public education on hygiene and physical distancing, bans on large gatherings, and so on. The ultimate goal of the "dance" is to keep *R* below 1,0.

"The hammer and the dance" is often visually presented as initially big wave of new cases, followed in time by a number of wavelets (Fig. 3). The earlier noted inability of the CCMS to adopt a new regime after the success of the lockdown is reflected in a discrepancy between the graph of the new cases in Croatia in time (Fig. 2) and the prediction of "the hammer and the dance" (Fig. 3) – the second wave in the Croatian case is not a wavelet, as "the hammer and the dance" would predict, but a wave of a magnitude comparable to the first one, if not even larger (Fig. 2). Even if "the hammer and the dance" is more a description of an ideal case than the real-world ones, the second wave in the Croatian case still seems to be too large.

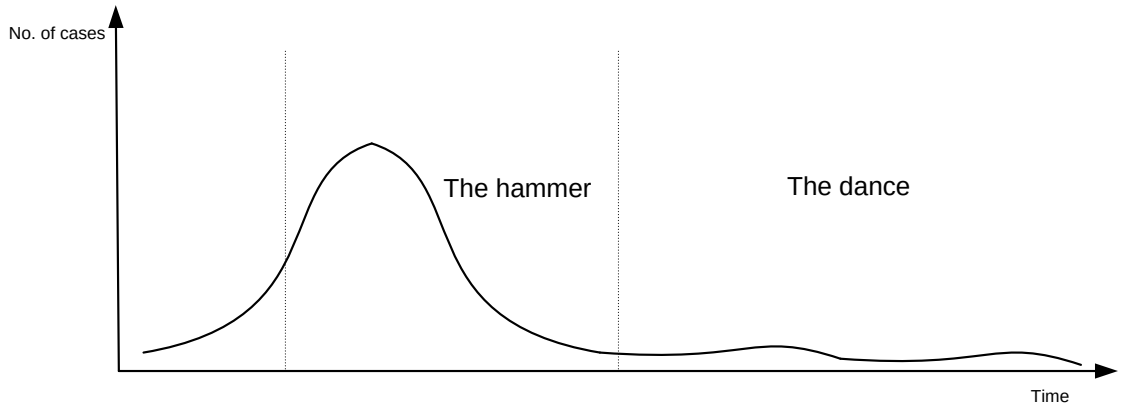

Figure 3. A sketch of "the hammer and the dance" (adapted from [70]).

The main difference between "the hammer and the dance" and the model used in this article is that the scope of "the hammer and the dance" is narrower. "The hammer and the dance" model is almost all about the trends in number of cases in time. It does not address wider, systemic notions, such as resilience, social cohesion, multiple sub-systemic levels, and scales. The simplicity of "the hammer and the dance" makes it suitable for public communication,

but it also hampers the model's ability to convey the underlying complexity of CMSs. This is not to say that the calculations behind "the hammer and the dance" are necessarily simple. On the contrary, they may be quite complex. However, the model itself serves as a sort of interface between the general public and the background calculations, the complexity of which is abstracted into an appealing metaphor expressed in only two words of everyday language – "the hammer" and "the dance". Fath, Dean and Katzmair's model, on the other hand, faces the underlying complexity head-on, albeit not by complex calculations, but by a description using the terminology of complex systems theory. The downside of such an approach, however, is that the model is not easily communicated to non-specialist audiences.

CONCLUSIONS, POLICY IMPLICATIONS, EXTENSIONS AND FUTURE WORK

Returning to the aim of the analysis stated in the Introduction, we conclude with what we have learned about the CCMS from the application of Fath, Dean and Katzmair's model. The first four conclusions have clear policy implications (PI), while the latter three are more closely related to modelling considerations:

- The CCMS successfully completed one cycle of the model, which is an important first step toward system's resilience. However, it can also be argued that the first cycle is easier to complete than the latter ones due to novelty. PI: Successes of the lockdown, or – more generally – any short-term successes in this crisis, should not lull anyone into complacency. This pandemic can only be overcome by long riders.
- The system is still searching for a new regime that will simultaneously enable a life of relative normalcy and contain an excessive spread of the virus. PI: Getting through a second cycle will take more willpower, but people have, hopefully, also learned something. At the very least, they have learned that they are not helpless in the face of the pandemic. Lockdown can successfully contain it, albeit at high economic and psychological costs. Somewhat paradoxically, learning that they are not helpless helped people also to unlearn some of the beneficial routines they had adopted during the lockdown – distancing, wearing face masks, using disinfectants, etc. Re-learning and applying those routines is a must.
- Social cohesion during the first cycle was strong and then it weakened. Strengthening social cohesion might facilitate the search for a new regime. PI: The rules of distancing, wearing face masks and isolating should be equal for all, be they politicians or ordinary people. The rules should be equally applied to wedding parties and other large festivities, including election victory celebrations. Equal treatment is important for strengthening both political trust and social cohesion. The COVID-19 crisis cannot be solved by imposing the will of any political grouping or majority vote. We need to make sense of this crisis together.
- While leadership during the first cycle was top-down, more bottom-up, emergent leadership is needed in the search for a new regime. PI: Bottom-up initiatives should be not only approved when they occasionally appear, but also systematically encouraged. Leadership should also be credible. Leading by example provides more credibility than merely pointing out other people's faults. Unity of purpose is also important. When the same leaders, who were justifying strict lockdown, a month or so later become reluctant to introduce any measures, this sends an inconsistent and confusing message. Such changes of policy need to be clearly and patiently explained to citizens, and not merely glossed over.
- The reproduction number and the number of new cases per 100 000 inhabitants are faster-moving candidates for the measure K of strain on resources, indicative of danger of resource overstretch. The number of tests conducted and the number of epidemiologists available, per 100 000 inhabitants, are slower-moving candidates for K.

- Small, local outbreaks represent small-scale disturbances that promote learning and allow upward flows of information through local – county-, municipal- and city-level – CMSs to the national CCMS. The analysis can be extended toward the individual level as the ultimate "local" scale, as well as toward supra-national and global levels as higher systemic scales.
- Fath, Dean and Katzmair's model conveys the underlying complexity of CMSs better than the simpler "hammer and the dance" model. The latter is, however, better suited for public communication.

This article is a case study in analysing CMSs' responses using systemic resilience models. In terms of Figure 1, our effort can be likened to only one of the small-scale cycles in the *K*-stage of systemic resilience models development and validation. Our case study needs to be extended in terms of modelling approaches, space and time.

There exist systemic resilience approaches other than the panarchy model used in this study. These include, for example, ecological information-based networks and models using statistical evidence of resilience [17]. Further research is needed to see whether such alternative approaches can also be used in CMSs' response analyses.

There have been more than 200 countries, territories, and international conveyances, such as cruise ships, afflicted by the COVID-19 pandemic worldwide [71]. A comparative study extending the framework outlined in this article should include a reasonably large sample of these. The sample might include developing nations, which, in addition to pandemic-related issues, face many other serious problems, such as lack of resources, political instabilities, armed conflicts, migrations and refugees-related problems, and already existing diseases. The earlier mentioned extension of the analysis toward supra-national levels should also be tried in such a comparative setting[5]. Of course, this would require far larger resources than what we had at disposal, and would be ideally addressed by an international project consortium.

Our study should also be extended in time. It remains to be seen whether systemic resilience models can account for CMSs' responses on larger time scales, including possible multiple pandemic waves.

REMARKS

[1]Whenever we speak of the number of cases, we mean the number of *detected* cases, which almost certainly underestimates the *true* number of cases, but it is difficult to assess by how much.

[2]Dates of beginning and ending of each stage are approximate. In some cases we chose dates that were particularly remembered in collective memory as "the day of the first COVID-19 case in Croatia" or "the beginning of lockdown", while in other cases these dates were more arbitrarily chosen. Indeed, it could be argued for each stage that it began or ended a few days earlier or later, without any consequences for our main claim – that the sequencing of events as they happened in the real world generally corresponds to the sequencing of stages as described by Fath, Dean and Katzmair [1].

[3]The original Croatian name of the Facebook group is „Jedni za druge".

[4]A more general way to pose the question of the time lag is what characteristic time is needed to observe on an aggregate level the effects of a change in contagion at the level of individuals.

[5]Extending the research framework toward supra-national levels might help address complex global-scale problems, such as healthcare supply chains management, which may be particularly important for developing countries. For example, hydroxychloroquine (HCQ), which is known to be an effective treatment for patients with autoimmune disorders, has also been used in COVID-19 treatment. Some developing nations are currently in danger of HCQ shortages and putting at risk patients depending on this medication, as demand for HCQ increases and high-income countries order additional supplies for potential COVID-19 prophylaxis [72].

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