Aalto University

OPEN ACCESS

This is an electronic reprint of the original article.
This reprint may differ from the original in pagination and typographic detail.

Santos, Andre; Sustar, Helena

Beyond service design: understanding complex challenges on a systemic level

Published in:
ServDes 2023 : Entanglements and Flows, Service Encounters and Meanings

DOI:
10.3384/ecp203078

Published: 28/11/2023

Document Version
Publisher's PDF, also known as Version of record

Published under the following license:
CC BY-NC

Please cite the original version:
Santos, A., & Sustar, H. (2023). Beyond service design: understanding complex challenges on a systemic level. In *ServDes 2023 : Entanglements and Flows, Service Encounters and Meanings: Conference Proceedings* (pp. 1565-1587). (Linköping Electronic Conference Proceedings; No. 203). Linköping University Electronic Press. https://doi.org/10.3384/ecp203078

This material is protected by copyright and other intellectual property rights, and duplication or sale of all or part of any of the repository collections is not permitted, except that material may be duplicated by you for your research use or educational purposes in electronic or print form. You must obtain permission for any other use. Electronic or print copies may not be offered, whether for sale or otherwise to anyone who is not an authorised user.

Beyond service design: understanding complex challenges on a systemic level

André Santos[1,2], Helena Sustar[1]
andre.f.santos@gmail.com, helena.sustar@aalto.fi
[1]Aalto University, Finland
[2]Aalto Design Factory, Finland

Abstract

Traditional user-centred design methodologies are no longer adequate for addressing the new way of thinking required by today's global challenges, considering the systemic complexity that service design has now reached. This paper addresses how a systemic approach can support service design practices to understand, map and represent complex challenges such as rural fires. The research methods include a systemic design approach that provides an in-depth view of the system and the institutional structure by identifying the actors and their relationships and unpacking the current issues. Moreover, this paper identifies intervention areas and suggests recommendations: more involvement and collaboration between the different actors and the fire prevention system can prevent and mitigate the risks of rural fires more efficiently. The study indicates that service design can benefit from a systemic approach by investigating the actors, roles, and interdependencies and identifying challenges and strategic intervention areas in complex systems.

Keywords: service design, systemic approach, complexity, rural fires

1. Introduction

Disasters are one of our time's most complex challenges; however, there are still many uncertainties on how to address them, with various disciplines offering many suggestions. Design can be essential in addressing dynamic, intertwined, conflicting issues such as disasters in an unpredictable setting and embedded in rapidly evolving environments (Sun & Yang, 2016). In this context, rural fires are a complex challenge: a long-term crisis for which the importance of urgent intervention is becoming increasingly evident. Rural fires are a natural part of the environment, affecting everything we value: our lives, homes, livelihoods, and services. These

conditions imply that solutions to the problem cannot be conceived as one-off concepts; instead, they require a strategic and systemic change of the current systems to tame complex challenges more efficiently (Suoheimo et al., 2021). The fires we have seen — burning hotter, quicker, with increased complexity and expense, and posing increased risk to habitats and communities — require a systemic understanding (Steffens, 2016).

In 1984, Papanek explored how design could tackle complex challenges and social concerns (Papanek, 1984). However, it is only recently that the number of studies investigating the systemic role of design has increased substantially (Besplemennova & Tassi, 2018; Buchanan, 2019; da Costa Junior et al., 2019; Forlizzi, 2013; Suoheimo et al., 2021). One of the disciplines that frequently works with sensitive and complex societal issues is service design (Akama, 2014; Sangiorgi et al., 2017; Suoheimo et al., 2021). According to Jones & van Ael (2021), service designers frequently encounter challenges involving interactions with more extensive systems. User-centred design methods are insufficient when service design problems reach the "system level" in size and complexity (Jones & van Ael, 2021).

Mager (2020) claims that service design is both a method and an approach, potentially impacting organisations' structural and cultural transformation significantly. Nevertheless, working with complex challenges, which are systemic and interconnected, requires service designers to interact with a broader range of actors within a system and adopt new mindsets and methodologies to develop innovative systemic solutions (Sun et al., 2022). According to Suoheimo et al. (2021), the ultimate goal of service design in tackling complex systemic challenges is to identify changes in areas such as society, politics, management, organisations, and sustainability. Therefore, it is possible to find many connections between current challenges' complexity and service design's evolving role in dealing with such issues.

When service designers focus on complex societal problems, they have to modify their practices and mindsets by adopting new approaches to working and thinking. With this in mind, this paper argues that current service design methods must tackle complex issues by applying a systemic approach to understand and address the complexity of challenges such as rural fires. By taking a systemic approach, service designers can learn more about the complexity of the problem they are trying to solve, enabling them to propose more holistic and systemic solutions (Jones, 2014).

As a result of the challenges mentioned above, the objective of this study was to continue the debate about the transition from user- and human-centred design methodologies towards a systemic design approach in the service design process. The overemphasis on addressing people's needs instead of tackling a complex

challenge by understanding the interconnections between nature, culture, and society may have undesirable effects on the system. In the interest of addressing the knowledge gap mentioned above, this study aimed to address the following research question (RQ):

How can a systemic approach support service design practices to understand, map and represent complex systems?

The subsequent structure of the paper presents work on the transition from services to thinking in systems, and it introduces the case study of rural fire management in Portugal. The study examines Portugal's rural fire management by analysing the current status of rural fire prevention, the actors involved, and their interconnections. A description of the research methodology is then provided, including the data collection, types of interviews, data analysis, and the systemic approach to understand, map, and expose the complex system of rural fire prevention in Portugal. The remainder of the paper is devoted to the findings and recommendations by identifying leverage points and proposing interventions at a strategic level. The final section reflects on the paper's findings and the contribution of a systemic approach to understand, map and represent a complex system supported by service design tools.

This paper was based on the first author's master's thesis in 2021, with the advisor being the second author (Santos, 2021). The authors want the study to shed light on the lessons learned, the challenges presented by the topic, and the pandemic constraints necessary for improving service design theory and practice.

2. From services to systems

According to the literature, service design is a human-centred, holistic, innovative, and iterative approach to developing or improving services (Meroni & Sangiorgi, 2011). However, these definitions are too narrow when considering the adoption of service design in the context of systemic challenges - the excessive focus on addressing people's needs when building services can produce constraints (Sun et al., 2022). As Jones & van Ael (2021) argue, service designers frequently encounter problems that interact with more extensive systems, which are referred to as service infrastructure. User-centred design methodologies are inadequate when service design difficulties reach the "system level" in size and complexity (Jones & van Ael, 2021).

During the last decade, academics of service design have become more aware of the complexities of the environment in which service design acts (Manzini, 2011;

Sangiorgi et al., 2017; Vink et al., 2021). Simultaneously, the service design has shifted from creating unique services to being an accelerator for broader societal transformations and an agent of change (Sangiorgi, 2011; Kimbell, 2014). Only with a move from a materialistic understanding of processes to grasping the deeper patterns underlying how existential human problems arise is it possible to explain, comprehend, and holistic design solutions that address complex challenges (Sepers, 2017; Rao et al., 2022; Charlesworth & Fien, 2022). For example, in disaster management, creating effective solutions by focusing on response alone is insufficient due to the variety and characteristics of the events, the environment, and the cultural context (Appleby-Arnold et al., 2021). As service design's contributions increase, the role of design can shift from problem-solving to the catalyst of progressive change that includes economic, social, and environmental values (Lam, 2017). By applying a systemic mindset to service design (Besplemennova & Tassi, 2018; Sun et al., 2022), designers can strengthen society's capacity to deal with challenging problems, such as disasters - designing methods that assist organisations in conceptualising and reacting to complex challenges (Boyer et al., 2013; Charlesworth & Fien, 2022).

Thinking in systems

Buchanan argues that design professions have evolved from designing individual symbols and artefacts to designing larger systems, environments, and organisations. He believes that design should not be limited to products or services but also consider the organisations that provide them (Buchanan, 1992). Similarly, Manzini (2011) claims that addressing complex issues involves a systemic approach that benefits the social economy and compels social innovation to discover the ideal solution. The systemic approach is a crucial skill set in design, given the predisposition for systemic change (Hill, 2012). Hill (2012) argues that many more experienced designers with systems may be the best suited to think strategically and systemically (Hill, 2012). This ability to address and understand complex challenges at a systemic level is intrinsically linked to the field of systems thinking. *Systems thinking* is a holistic approach that emphasises the interdependence of a system's parts and how systems work over time (Meadows, 2008). In this study's context, Portugal's fire management system emerges from the actors, policies, resources, and context relationships. Its emergent property is the prevention and response to rural fires.

3. Case study: rural fires in Portugal

Portugal is the European country that suffers the most from rural fires, both in the number of fires and burnt areas, compared to countries such as Spain or Greece (Lourenço, 2018). Summers in the country have become warmer, drier, and longer because of climate change, which increases the risk of rural fires. In addition to the weather conditions, fire analysts also point to other factors such as rural abandonment, shifts in land use with farmland and forested areas left unmaintained, and land ownership division trends that discourage investment in forest management and fire planning (Mateus & Fernandes, 2014; Meira Castro et al., 2020; Mira & Lourenço, 2019). These factors resulted in changes in the conventional causes of fire ignition in recent decades, with the origins increasingly being anthropogenic in Portugal and other Mediterranean European countries (Catry et al., 2010; Meira Castro et al., 2020; Nunes et al., 2016). The rural fire crisis has worsened due to periodic structural reforms by the government and its diminished capacity to intervene in the absence of a private-sector counterpart. Before the 2003 and 2005 rural fire disasters, fire prevention practices were notoriously reactive, contradictory, and short-sighted (Mateus & Fernandes, 2014; Nunes et al., 2014). Fire management has consistently strengthened fire control capabilities rather than tackling underlying factors, including property ownership structure, timber and land conservation, state authority, social stability, agriculture, energy, and soil sector regulation (Mateus & Fernandes, 2014).

Portugal's political approach to fires has been interventionist. Over the years, various management and control tools (legislation, policy, and planning) have been implemented, as well as financial instruments. These instruments are continually tweaked and revised, often with potentially conflicting results. As a result, there is inconsistency, inadequate understanding of applicable rules, and, perhaps most importantly, a failure to take a clear direction toward successful performance. The quantity of national-level strategic documents issued indicates uncertainty in the system (Table 1).

Year	Plan
1996	Forest Policy Bases Law
1999	Portuguese Forest Sustainable Development Plan
2003	Action Plan for the Forest Sector

2003	Forest Sector Structural Reform
2005	Operational Plan of Forest Fires Prevention and Suppression
2006	National Plan of Forest Defence Against Fires (2006-2018)
2006	National Forest Strategy
2020	National Plan for Integrated Fire Management

Table 1. National-level Portuguese forest strategies and plans (1996-2020) (adapted from Mateus & Fernandes, 2014).

In the aftermath of the rural fires in 2017, followed by a study on the new Integrated Rural Fire Management System (SGIFR), the Agency for Integrated Rural Fire Management (AGIF) emerged as the leading actor in the integrated analysis, planning, evaluation and strategic coordination of the SGIFR, in collaboration with the National Authority for Emergency and Civil Protection (ANEPC) and the Institute for Nature Conservation and Forests (ICNF) (AGIF, 2020). The SGIFR is built on two action pillars, Rural Fire Management (RFM) and Rural Fire Protection (RFP), representing a significant shift from the previous plan, which was in effect from 2006 to 2018.

4. Methodology

The research methodology for this study was primarily a qualitative research approach. Initially, it combined participatory processes and ethnographic methods; however, COVID-19 restrictions limited the scope of the study. The initial plan was to travel to Portugal, have the first round of interviews with experts, analyse the data, then the second round of interviews, and organise a collaborative workshop for co-creation with the relevant actors within the system. Instead, given most participants' role in responding to the COVID-19 crisis, the workshop was removed from the research process. Only one round of interviews (conversational and semi-structured) took place.

Data collection

Documentary information from the national government and agencies, such as legislation, decrees, and national strategies, was collected and analysed to

complement the knowledge gained from the literature review to understand the rural fire management system.

In January 2020, at the beginning of the collection process, the Portuguese government published a new strategy for the new National Plan for Integrated Rural Fire Management (PNGFR). The national strategy document supported this study throughout the research project. Moreover, the attendance at the Closing Seminar of the Public Discussion on the National Plan for Integrated Management of Rural Fires in Portugal provided valuable information on how the actors view the issue. After analysing the documentation and learning more about Portugal's rural fire management system structure, participants were selected and contacted for interviews.

In total, thirteen in-depth interviews were conducted with participants in three formats: conversational, semi-structured, and email (Table 2). They were spread out over four months, from February to June 2020. The number and profiles of interviews were based on three factors: 1) time and resource limitations to transcribe and analyse the interviews; 2) capacity to reach out to potential participants; and 3) participants' availability. Table 2 presents an overview of the participants according to their organisation type, role and level of activity.

Interview	Role	Organisation	Level of action	Interview method
I01	President	Government agency	National	Semi-structured (in-person)
I02-A	Researcher	Research lab	National	Conversational (online)
I02-B	Project manager	Research lab	National	Conversational (online)
I03-A	Director	Government agency	National	Conversational (online)
I03-B	Civil servant	Government agency	National	Conversational (online)
I04	Director	Forest producer	Local/National	Semi-structured (online)

I05	Assistant director	European institute	Europe	Conversational (in-person)
I06	Member	Environmental NGO	National	Semi-structured (online)
I07	Vice-president	Environmental NGO	Local	Semi-structured (online)
I08	President	Forest association	Local/National	Semi-structured (online)
I09	Head of Forestry Technical Office (GTF)	Municipality	Local	Structured (email)
I10	Researcher	University	National	Semi-structured (online)
I11	Head of Forest Sappers	Municipality	Local	Structured (email)

Table 2. Generic description of interviewees.

Data analysis

It was possible to dissect the system and unpack existing collaboration principles and activities of rural fire prevention through data analysis. First, the interviewee's responses were analysed and compared to others to find possible contradictions. However, this strategy was abandoned due to difficulty finding new understandings and connections. Instead, the authors selected the affinity diagram method to analyse the data (Hartson & Pyla, 2012). This method made it possible to organise the statements into group.

The systemic approach was applied as a natural method to understand, study, and expose the complex system of rural fire prevention in Portugal (Ryan, 2014). According to Ryan (2014), this approach enables different teams to gain a holistic view of the problem and quickly transform new ideas into actions. The actors' roles and responsibilities could only be analysed by first comprehending the underlying system (Figure 1).

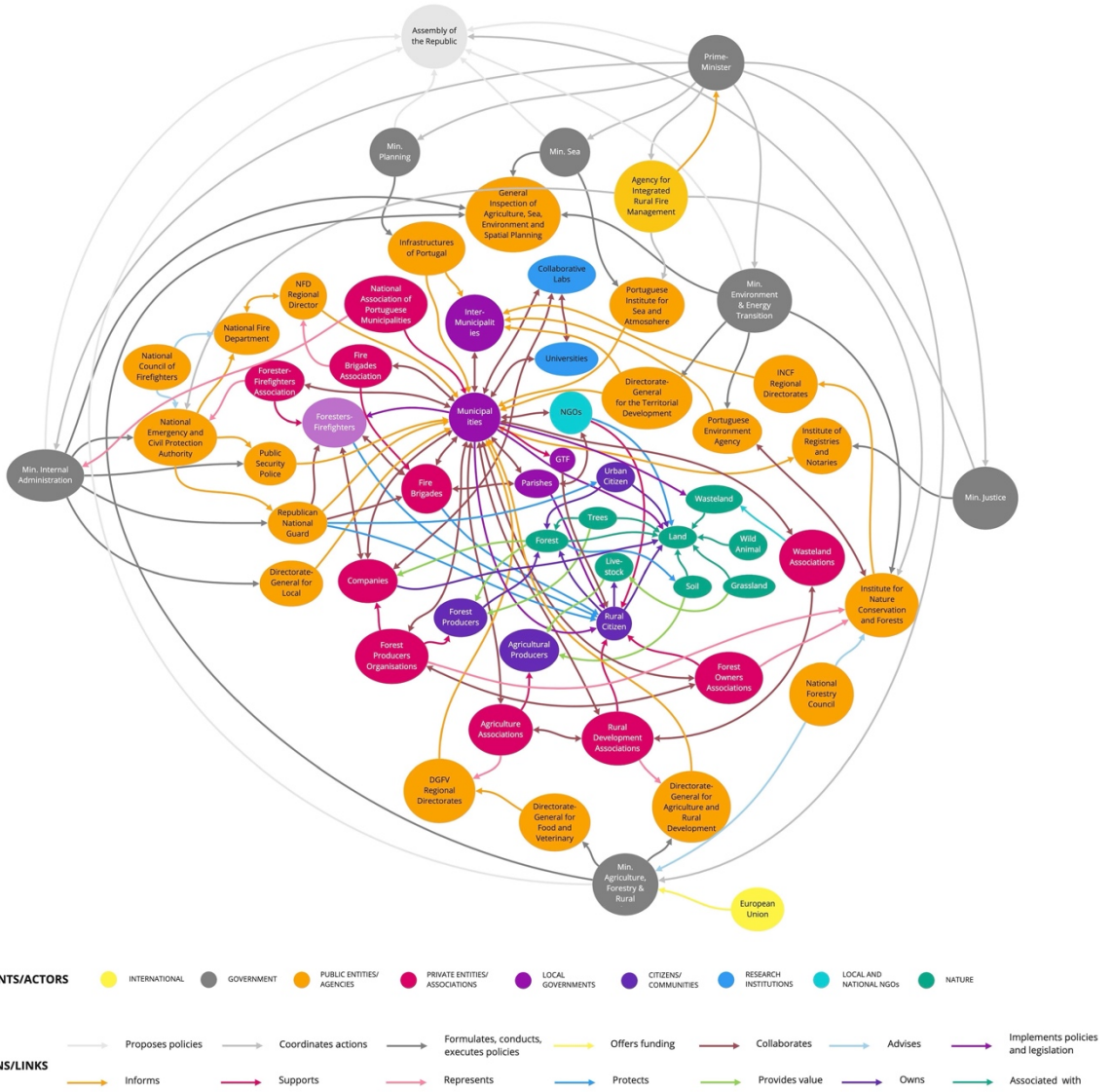

Figure 1. Systemic overview of the rural fire prevention system.

5. Results and findings

Based on the literature review and interviews, this section presents the five main findings of this research concerning the understanding and study of rural fire prevention in Portugal (Figure 2). The first three themes cover different aspects regarding the institutional system, the role of the actors and the characteristics of the Portuguese rural areas. The last two themes relate to recognising the role of the fire and the forest as actors in the rural fire prevention system.

Figure 2. Visual representation of the five themes (and sub-themes) that emerged from the analysis.

Roles and Responsibilities of Actors

The complexity of rural fires involves many actors, resulting in a mismatch of skills and understanding of the problem. The interview results show that different actors have different roles and responsibilities within the system. Those responsibilities can be divided into four levels of action: the national, the regional, the local, and the individual. These action levels demonstrate how the system is structured and various actors' impact from a strategic to an operational level and general population.

Institutional Structure, Mindset and Attitude

a) National policies unsuitable for local context

Several interviewees said that the existing framework of rural fire management needs to be more consistent. Periodic modifications to the organisational model have distorted the system view in the last 20 years. According to one interviewee, a long-term vision agreed upon by all system participants is crucial to stabilising it. The first stage focuses on rural legislation and policy-making to integrate academic and scientific information. This vision could be accomplished by recognising nature's role in averting rural fires and including topics like biodiversity and climate change.

The constant inconsistencies, contradictions, and law change lead to legal incompatibilities with rural areas' current state. Greater forest activity regulation can be achieved by involving local governments and communities in formulating and planning forestry policies that meet landowners' needs. Coordination must be decentralised and territorialised to attain diversity and adapt to each municipality with adequate support and monitoring.

b) Lack of collaboration across actors

The existing institutional structure lacks collaborative mechanisms, which is a concern. Strategic and tactical levels must cooperate. One participant said organisations focus more on themselves and results than working collaboratively due to the assessment systems that evaluate and monitor individual performance over collaborative performance. These evaluation methods are not collaborative. Instead of preventing fires, they operate in silos and focus on suppressing them. One interviewee defends that closer proximity and dialogue with organisations and municipalities can promote trust capital. Sharing resources and knowledge, defining responsibilities, and engaging in various activities encourage responsibility, empowerment, and ownership.

c) Gaps within knowledge transfer

The power of knowledge is vital to mitigating risks of rural fires. According to one interviewee, many opinions within governmental organisations are founded without having contact with the field. Moreover, several people contributing to the national strategies do not possess the appropriate forest management skills to participate in decision-making. Hence, supported by a less hierarchical approach, promoting knowledge sharing at the strategic, tactical and operational levels involving research centres and academia is necessary.

The urban population's attitudes and behaviours are incompatible with the rural areas' reality. Therefore, education is fundamental to changing risk behaviours and recognising the forest as a factor of production and ecological and economic value creation.

d) Inconsistent internal and external communication

Communication is essential to preventing rural fires. One researcher identifies three communication dimensions - within the organisation, between organisations, and with the population - that are interconnected. For instance, poor and unclear communication within ICNF will directly impact communication with the local governments, which, as a result, will misguide citizens' behaviour and mindset. This miscommunication and misinformation contribute to an incorrect perception of the appropriate behaviours in rural areas.

Detailed documentation and understanding of how national agencies and local governments collaborate, think, and act helps improve internal and public communication. A structured and comprehensive communication strategy could support institutional, political, and local paradigm shifts.

Management and Heterogeneity of Rural Areas

a) Diversity of the Portuguese territory

A heterogeneous climate and territory characterise Portugal. For example, the Atlantic climate area is more prone to rural fires; in contrast, the risk of rural fires in the southern rural interior is low. This heterogeneity demonstrates that forest management policies should be more adaptable to each area's specificities. External factors such as climate can influence the level of vulnerability of society and increase rural fires. Acknowledging the role of climate and the heterogeneity of the Portuguese territory in the rural fire management system is the first step to reducing vulnerability and protecting people, properties, and rural environments, particularly forests and their ecosystems.

b) Value of the rural areas

People no longer depend on rural areas to generate income. Rural lands are not seen as an essential resource for the Portuguese economy because they are not profitable. One interviewee proposes a new type of economy that uses local resources to reduce fuel loads and rebalance the ecosystem. Another interviewee supports increasing landowners' remuneration to encourage them to intervene in their lands. Supporting the landowners to promote better land management will result in better prevention, generating value and employment at the local level. New

production forms and management solutions can enable economic activities that generate value and bring people back to rural areas.

c) Management and use of rural areas

Rural areas today have an extremely high average age and a relatively low population density. Villages have become more desertified, and towns and cities started to grow, which led to the current situation. The abandonment of lands is linked to the low values of compensation by the forest industry. Forest and landowners own areas where the maintenance costs are very high and not financially sustainable, contributing to the absence of appropriate land management. Many landowners live in cities and are unaware of their rural assets. Desertification has hindered the collection and registration of information on landowners' legal rights, despite legal norms requiring them to maintain and manage their land.

The Phenomenon of Fires

a) Cultural perception

The Portuguese society's perception of fire is based on amiss cultural beliefs. Even though rural fires have a negative impact, the phenomenon of fire is an ecological process comparable to other natural phenomena such as scrublands, agriculture, and forest - fire is a tool that can be used under controlled environments for land and habitat management. Ecological ecosystems need fire to regenerate; otherwise, they deteriorate and disappear. This fact demonstrates that accepting fire's positive and negative effects is paramount. One interviewee claims that fire is a social and political issue that should be addressed at the governmental and strategic levels through policies that better reflect fire’s impact on social and natural environments. These policies can empower locals and help communities create fire-prevention mechanisms and structures.

b) Causes of fires

The leading causes of rural fires are climate change and human behaviour. Even though fires are becoming more frequent and intense due to drier and warmer conditions, failure to control them can result in severe social, economic and ecological consequences. One research participant states that the rural abandonment contributed to the forest’s abandonment and fuel accumulation in the lands, which, without any treatment, can activate the potential occurrence of fires. Although the biomass in the soil affects the condition and the impact of rural fires, the issue is not related to the types of trees; instead, it is linked to the absence of land management and the loss of land’s economic value.

c) Attitude towards prevention

According to most interviewees, the rural fire management system's focus should be prevention rather than suppression. Focusing on prevention reduces the resources for suppression and enables control of the number of ignitions throughout the summer. Fires must be dealt with during the winter through forest management policies and action plans suitable to the local context - investment in prevention is more relevant than acquiring new equipment to fight rural fires.

The Forest as an Agent

a) Forest as part of the ecosystem

Organisations at all levels consider forest ecosystems essential for mitigating rural fire risks and regenerating the ecosystem. The statement above reinforces the importance of landowners and rural and urban citizens acknowledging the role of forests in preventing rural fires. Society cannot overstate the value of forest ecosystems. All citizens should be responsible for caring for forests since their ecosystem components clean the air and water, control the environment, recycle nutrients and wastes, and sequestrate carbon emissions through the soil and the vegetation, slowing atmospheric pollution and mitigating global warming. As stated by one interviewee, these ecosystem services could provide economic compensation to forest and landowners, balancing their land management costs. One interviewee defends that forest-specific measures should focus on forestry, reforestation after fires, and better management. Instead, current policies promote deforestation, introducing new types of non-burning trees and maintaining those to do that. Another participant from the research field suggests afforestation as an alternative method - creating forests in new areas increases carbon capture and prevents other disasters, such as floods.

b) Forest's value

When landowners modify natural forest habitats, they overlook forest ecosystems' potential implications. For that reason, national and local strategies must promote good practices regarding land management and mitigation risk of rural fires. Forest producers should be required to create a forestry plan during the production cycle that allows actions to reduce fuel load, control hotter risk points of fire, and mitigate this risk with specific interventions. By doing so, they can protect their lands, utilise the forests' resources, and generate income.

6. Recommendations

This section presents five recommendations that address the core themes presented in the previous section (Table 3). These recommendations propose new interventions at a strategic level of the whole ecosystem - a minor intervention can result in a significant behaviour shift. The strategic recommendations are formed using Meadows' list of leverage points (1999). According to Meadows (1999), leverage points 7, 8, 9, 10, 11 and 12 are less effective because they involve physical system components and information flow, which takes more resources and effort to change. Even the paradigm that forms our ideologies is constrained and beyond human understanding (Meadows, 2008). Therefore, only leverage points from 6 to 4 are explored to remain within the rural fire prevention system (Figure 3).

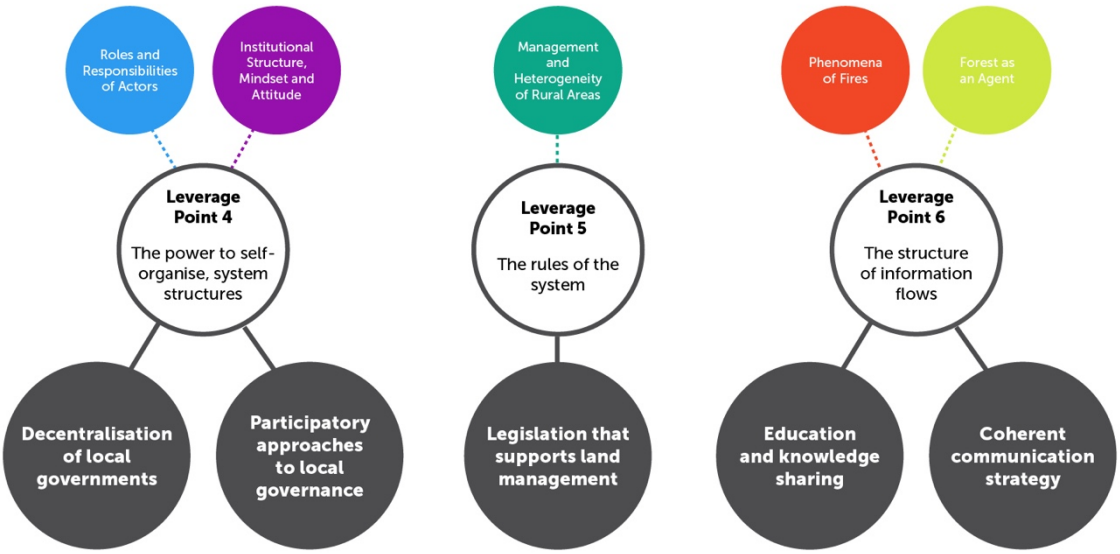

Figure 3. Strategic recommendations associated with leverage points.

Recommendation	Description
Decentralise local governments	Decentralising decision-making benefits landowners and local communities. Local governments will be able to define and adjust local policies independently of government agencies, improving management and organisational decision-making, increasing government accountability, reducing bureaucracy and promoting action.

Promote participatory approaches to local governance	Decentralisation promotes civic interest in local decision-making. Landowners participate in land management and fire prevention decisions and policies. Participatory local government strategies can increase landowners' access to policy-making institutions, change official attitudes toward public involvement, and offer incentives for participation. This strategy improves policy deliberation and government transparency, locals' wishes and needs, and instils landowners with a greater trust in their government.
Adjust legislation that supports land management	Current legislation compensates landowners for forest ecosystem services, but many locals ignore their legal responsibilities. Instead of punishing harmful behaviour, a potential strategy is to support landowners with adequate land management and preventive actions against rural fires. This government support can encourage forest owners to manage and prevent property damage proactively, encouraging new management solutions that could generate value and bring people back to rural areas.
Promote education and knowledge sharing	Rural fire prevention requires a new approach to informing about fire and forest ecology. Rural fire prevention requires a new approach to informing about fire and forest ecology. Promoting the value of forests and fire as natural phenomena may increase citizen agency and affect behaviour. It acknowledges fire's role in eliminating undesirable plants from natural environments to lower fuel loads and fire danger. Individuals become more conscious of system actors and make sensible decisions.
Establish coherent communication strategies	For knowledge sharing to occur, it is crucial to develop a communication strategy that addresses all actors in the system. Local governments' preventive actions reach locals, but their communication should be more precise and transparent and promote new behaviour. Owners should be aware of the impact their actions have on local ecosystems. National and local governments could promote this awareness by educating people about forests and fire, changing society's perception of fire and the role of forests. A communication strategy involving small-time property owners and local (and national) actors can change mindsets through civic activities and landowner-specific communications.

Table 3. List of strategic recommendations based on the findings.

7. Discussion and conclusion

Service design has been shifting from creating unique services to being a catalyst for broader societal transformations and an agent of change (Sangiorgi, 2011; Kimbell, 2014). The objective of this study was to continue the discourse of this transformation from user and human-centred design methods to a systemic design approach in the service design process. The overemphasis on meeting people's needs instead of addressing a complex problem by understanding the interconnections between nature, culture, and society might result in issues on a systemic level.

This study explored the understanding of rural fire prevention on a systemic level, the actors' role in rural fire prevention and the value of a systemic approach in service design when addressing complex challenges - factors overlooked in previous studies while corroborating earlier results in the literature. These factors will be discussed below and simultaneously answer the research question of “How can a systemic approach support service design practices to understand, map and represent complex systems?”.

First, the context of this case study allowed a comprehensive analysis of the rural fire prevention system and uncovered actors' challenges and interdependencies. The research findings suggest that service designers can better understand complex challenges on a systemic level by adopting a systemic approach. Other studies have shown that a systemic approach is essential when tackling complex issues, including institutional change in governance (Rava, 2016), climate change adaptation (Tanjeela, 2015), and natural disasters (Charlesworth & Fien, 2022).

Second, in contrast to some studies (Buehring & Bishop, 2020; Huang & Anderson, 2011), this research used a top-down approach, with participants from government agencies, local governments, and private and nonprofit sectors. Through a top-down approach, the results revealed how system actors perceive rural fires, identified the role of other actors, and how to mitigate rural fire risks. One of those challenges was the need for more collaboration and communication across different actors and organisations, which hinders the process of engaging and long-lasting changes in behaviour (Akama et al., 2012).

Third, the increased complexity of societal challenges has shown that traditional service design practices no longer apply to society's current issues (Jones & van Ael, 2021). Therefore, the case study establishes systems thinking as a basis for service design's core competencies and professional progress with complex challenges (Buchanan, 1992; Sun et al., 2022). Similarly, the studies by Komatsu Cipriani &

Rossi (2018) and Sun et al. (2022) argue that service designers must develop their methodological and conceptual prowess in the future.

Fourth, embodying a systemic mindset in the service design process (Besplemennova & Tassi, 2018; Sun et al., 2022) allows for understanding and addressing complex, multi-actor infrastructure systems such as those used in rural fire prevention. As service design's contributions increase, the role of design can shift from problem-solving to being a catalyst for economic, social, and environmental values-based progressive change (Lam, 2017).

In conclusion, the study demonstrates that service design can benefit from a systemic approach by investigating the actors, roles, and interdependencies and identifying challenges and strategic intervention areas in Portugal's rural fire prevention system.

Applying a systemic approach enabled to: 1) identify and examine the role of the different actors within the rural fire prevention system; 2) analyse, synthesise and reflect on the challenges towards rural fire prevention; and 3) formulate strategic recommendations while working within the constraints of national and local needs in rural fire prevention in Portugal. The research followed Meadows's (2008) idea to simplify and set boundaries in the system to limit the research's complexity level. Creating boundaries and focusing on prevention led to a more detailed analysis of mitigating risks and preventing rural fires.

The study's findings should be interpreted with caution due to the small sample size of interview participants. Additionally, adopting a collaborative approach involving the participants in the process could have resulted in more substantive and neutral results, avoiding the limitations of a lack of collaboration.

This study provides valuable insights into previous efforts for service design to address complex challenges through a systemic design approach. It adapts well-established design competencies to define, map, suggest and reconfigure complex systems and processes. A systemic approach in the design process enables a comprehensive understanding of complex, multi-stakeholder infrastructure systems such as disasters, healthcare, or transportation.

References

AGIF. (2020). *National Plan for Integrated Rural Fire Management*. AGIF.

Akama, Y. (2014). Passing on, handing over, letting go – the passage of embodied design methods for disaster preparedness. In D. Sangiorgi, D. Hands, & E. Murphy (Eds.), *Proceedings of the Fourth Service Design and Service Innovation Conference* (pp. 173–183). Linköping University Electronic Press. https://ep.liu.se/ecp/099/ecp14099.pdf

Akama, Y., Chaplin, S., Philips, R., & Toh, K. (2012). Design-led strategies for bushfire preparedness. In C. Gertzos (Ed.), *Proceedings of the Disaster and Emergency Management Conference* (pp. 407–424). AST Management.

Appleby-Arnold, S., Brockdorff, N., & Callus, C. (2021). Developing a "culture of disaster preparedness": The citizens' view. *International Journal of Disaster Risk Reduction*, *56*, 102133. https://doi.org/10.1016/j.ijdrr.2021.102133

Besplemennova, Y., & Tassi, R. (2018). Systems Thinking for Service Design. In S. Barbero (Ed.), *Proceedings of Relating Systems Thinking and Design (RSD7) 2018 Symposium* (pp. 23–26). Systemic Design Association. http://openresearch.ocadu.ca/id/eprint/2736/

Boyer, B., Cook, J., & Steinberg, M. (2013). *In Studio: Recipes for Systemic Change*. Sitra. http://helsinkidesignlab.org/pages/studio-book.html

Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*, *8*(2), 5. https://doi.org/10.2307/1511637

Buchanan, R. (2019). Systems Thinking and Design Thinking: The Search for Principles in the World We Are Making. *She Ji: The Journal of Design, Economics, and Innovation*, *5*(2), 85–104. https://doi.org/10.1016/j.sheji.2019.04.001

Buehring, J., & Bishop, P. C. (2020). Foresight and Design: New Support for Strategic Decision Making. *She Ji: The Journal of Design, Economics, and Innovation*, *6*(3), 408–432. https://doi.org/10.1016/j.sheji.2020.07.002

Catry, F., Rego, F., Silva, J., Moreira, F., Camia, A., Ricotta, C., & Conedera, M. (2010). Fire Starts and Human Activities. In J. Silva, F. Rego, P. Fernandes, & E. Rigolot (Eds.), *Towards Integrated Fire Management – Outcomes of the European Project Fire Paradox* (pp. 9–34). European Forest Institute. http://www.repository.utl.pt./bitstream/10400.5/15236/1/REP-FIRE Paradox-efi_rr23.pdf

Charlesworth, E., & Fien, J. (2022). Design and Disaster Resilience: Toward a Role for Design in Disaster Mitigation and Recovery. *Architecture*, *2*(2), 292–306. https://doi.org/10.3390/architecture2020017

da Costa Junior, J., Diehl, J. C., & Snelders, D. (2019). A framework for a systems design approach to complex societal problems. *Design Science*, *5*, e2. https://doi.org/10.1017/dsj.2018.16

Forlizzi, J. (2013). The Product Service Ecology: Using a Systems Approach in Design. *Relating Systems Thinking and Design 2013 Symposium Proceedings*, 27.

Hartson, P., & Pyla, P. (2012). *The UX Book: Process and guidelines for ensuring a quality user experience*. Elsevier.

Hill, D. (2012). *Dark matter and trojan horses: A strategic design vocabulary*. https://www.overdrive.com/search?q=5786581D-164D-446A-91FE-06BFBF21572C

Huang, T., & Anderson, E. (2011). *Designing Disaster-Resilient Communities*. IDSA Education Symposium, New Orleans, USA.

Jones, P. H. (2014). Systemic Design Principles for Complex Social Systems. In G. S. Metcalf (Ed.), *Social Systems and Design* (Vol. 1, pp. 91–128). Springer Japan. https://doi.org/10.1007/978-4-431-54478-4_4

Jones, P., & van Ael, K. (2021). Design for Services in Complex System Contexts. *Touchpoint*, *12*(2), 30–35.

Kimbell, L. (2014). *The service innovation handbook: Action-oriented creative thinking toolkit for service organizations*. BIS publishers. https://ualresearchonline.arts.ac.uk/id/eprint/9110

Komatsu Cipriani, T., & Rossi, M. (2018). Working with complexity: A contemporary skill framework for service designers. In A. Meroni, A. M. Ospina Medina, & B. Villari (Eds.), *ServDes2018: Service Design Proof of Concept—Proceedings of the ServDes2018 Conference* (pp. 105–116). Linköping University Electronic Press. http://www.ep.liu.se/ecp/150/009/ecp18150009.pdf

Lam, B. (2017). Applying strategic design as a holistic approach to investigate and address real world challenges. *Strategic Design Research Journal*, *10*(2), 164–171. https://doi.org/10.4013/sdrj.2017.102.09

Lourenço, L. (2018). Forest fires in continental Portugal: Result of profound alterations in society and territorial consequences. *Méditerranée*, *130*. https://doi.org/10.4000/mediterranee.9958

Mager, B. (2020). The Future of Service Design. In T. Chydenius, A. Enriconi, B. Mager, M. Manhães, A. Schreider, J. Weber, & K. Wongpichet (Eds.), *The Future of Service Design* (pp. 14–21). KISD | TH Köln. https://www.academia.edu/44459133/The_Future_of_Service_Design

Manzini, E. (2011). Introduction. In A. Meroni & D. Sangiorni, *Design for Services* (pp. 1–6). Routledge. https://doi.org/10.4324/9781315576657

Mateus, P., & Fernandes, P. M. (2014). Forest Fires in Portugal: Dynamics, Causes and Policies. In F. Reboredo (Ed.), *Forest Context and Policies in Portugal* (Vol. 19, pp. 97–115). Springer International Publishing. https://doi.org/10.1007/978-3-319-08455-8_4

Meadows, D. H. (1999). Leverage Points: Places to Intervene in a System. *The Sustainability Institute*. http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.

Meira Castro, A., Nunes, A., Sousa, A., & Lourenço, L. (2020). Mapping the Causes of Forest Fires in Portugal by Clustering Analysis. *Geosciences*, *10*(2), 53. https://doi.org/10.3390/geosciences10020053

Meroni, A., & Sangiorgi, D. (2011). *Design for Services*. Routledge. https://doi.org/10.4324/9781315576657

Mira, M., & Lourenço, L. (2019). Big forest fires of 17 June 2017 in Portugal and examples of the determination of respective causes? *Territorium: Revista Portuguesa de riscos, prevenção e segurança*, *26 (II)*, 49–60. https://doi.org/10.14195/1647-7723_26-2_4

Nunes, A., Lourenço, L., & Castro, A. C. M. (2014). Principais causas dos incêndios florestais em Portugal: Variação espacial no período 2001/12 [Main causes of forest fires in Portugal: Spatial variation in the period 2001/12]. *Territorium*, *21*, 135–146.

Nunes, A. N., Lourenço, L., & Meira, A. C. C. (2016). Exploring spatial patterns and drivers of forest fires in Portugal (1980–2014). *Science of The Total Environment*, *573*, 1190–1202. https://doi.org/10.1016/j.scitotenv.2016.03.121

Papanek, V. (1984). *Design for the real world: Human ecology and social change* (2nd ed.). Thames & Hudson.

Rao, V., Dzombak, R., Dogruer, D., & Agogino, A. (2022). Project-Based Learning in Disaster Response: Designing Solutions with Sociotechnical Complexity.

Proceedings of the Design Society, *2*, 2373–2382. https://doi.org/10.1017/pds.2022.240

Rava, N. (2016). *Designing for Policy and Institutional Change in Governance*. 11.

Ryan, A. (2014). A Framework for Systemic Design. *FormAkademisk - Forskningstidsskrift for Design Og Designdidaktikk*, *7*(4). https://doi.org/10.7577/formakademisk.787

Sangiorgi, D., Patrício, L., & Fisk, R. (2017). Designing for Interdependence, Participation and Emergence in Complex Service Systems. In D. Sangiorgi & A. Prendiville (Eds.), *Designing for Service Key Issues and New Directions* (pp. 49–64). Bloomsbury Visual Arts. http://dx.doi.org/10.5040/9781474250160.ch-004

Santos, A. (2021). *A systemic approach to fire prevention: A case study of rural fires in Portugal* [Master's thesis, Aalto University]. Aaltodoc http://urn.fi/URN:NBN:fi:aalto-202106217657

Sepers, F. (2017). An Integral Design Framework—Designing a global village. *The Design Journal*, *20*(sup1), S1566–S1579. https://doi.org/10.1080/14606925.2017.1352681

Sun, Q., Jenkins, P., & Liu, Z. (2022). Service Design Practice and Its Future Relevance. *The 23rd Dmi: Academic Design Management Conference Proceedings*, 359–368.

Suoheimo, M., Vasques, R., & Rytilahti, P. (2021). Deep Diving into Service Design Problems: Visualizing the Iceberg Model of Design Problems through a Literature Review on the Relation and Role of Service Design with Wicked Problems. *The Design Journal*, *24*(2), 231–251. https://doi.org/10.1080/14606925.2020.1838696

Tanjeela, M. (2015). Coping With Disasters: The Potentiality of Indigenous Knowledge and Community Based Responses to Climate Change Adaptation. *Proceedings of the ANDROID Residential Doctoral School*, 13.

Vink, J., Koskela-Huotari, K., Tronvoll, B., Edvardsson, B., & Wetter-Edman, K. (2021). Service ecosystem design: Propositions, process model, and future research agenda. *Journal of Service Research*, *24*(2), 168–186. https://doi.org/10.1177/1094670520952537