THE 'PAYBACK' OF CITIZEN SCIENCE
A PARTICIPATORY EVALUATION AND IMPACT-ASSESSMENT MODEL FOR SOCIAL INNOVATION PROJECTS

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ABSTRACT

Citizen science projects for social innovation present solutions to society's complex challenges (da Silva et al. 2019). However, evaluating their impact is challenging (Bornmann 2012); an integrative impact-assessment framework considering all innovation process steps and impact dimensions while accounting for all participants' perspectives does not yet exist (Smit and Hessels 2021). One frequently used framework to evaluate impact beyond the academic sector is the Payback Framework proposed by Buxton and Hanney (1996). In its current specification, this framework does not apply to participatory projects due to its unilateral scientific perspective. This study applied the theory adaptation approach (Jaakkola 2020) to extend the Payback Framework's scope by informing it with the lens of another conceptual approach, namely the Service-Dominant logic. The study aimed to adapt the Payback Framework for citizen science projects, creating a Citizen Science Payback Framework. The new framework was created by adding the degree of external participation as a third component. The new component captures citizen participation and thus indicates the involvement of citizens in the evaluation process.

INTRODUCTION

Social innovations, which are defined as "novel solutions for social problems (…)" (Phills et al. 2008, p. 38), promise to overcome today's diverse social challenges (Pol and Ville 2009), including poverty, inequality, and the ageing population. A popular approach to social innovation is citizen science, the "participation of citizens in scientific processes" (Bonn et al. 2016 p. 13). This is the case because the involvement of citizens presents a relevant resource for improving the processes of research and innovation (Senabre Hidalgo et al. 2021). Citizen science can be described as an innovative way to develop and foster social innovation (Butkevičienė et al. 2021). The "collaborative generation of knowledge by academics working alongside stakeholder from other sectors" (Greenhalgh et al. 2016, p. 393) is usually called co-creation and is widely believed to increase research impact (Greenhalgh et al. 2016). Citizen science projects show a high diversity regarding the degree of participation (Schaefer and Kieslinger 2016), whereas the project outcomes and thus the impact is influenced by the degree of citizen participation during the project process (Shirk et al. 2012).

Over the past decades, various methods for evaluating research impact were generated when impact is defined as the effect research generates beyond building academic knowledge, including benefits for society, culture, and economy (Bornmann 2012; Spaapen and van Drooge 2011). However, most of the models only consider the academic perspective in the evaluation process, although a participatory evaluation complies to the normative aspect regarding democratic inclusion of multiple perspectives and the pragmatic justification that enhanced participation leads to better results (Springett 2017). While stakeholder participation is recognised as a relevant component of the evaluation, particularly impact evaluation, it remains theoretically and conceptually underdeveloped (Smit and Hessels 2021; Springett 2017).

Contributing to this gap, the theory-adaption approach (Jaakkola 2020) was used to expand the application domain of the Payback Framework, which is the most widely used and adapted model and the best approach to assess the impact of research projects beyond academic impact (Bornmann 2013; Donovan 2011; Penfield et al. 2014), to citizen science. This is done by applying the Service-Dominant logic (S-D logic) (Vargo and Lusch 2004) as a new lens to create an evaluation framework for citizen science social innovation projects. This Citizen Science Payback Framework considers the collaborative process of knowledge generation in the evaluation process by adding a new component that evaluates the citizen participation at each project step and indicates upon this the inclusion of the citizens in the evaluation process.

The remainder of this paper is organised as follows. First, it introduces the theoretical background on citizen science as an area of application, the Payback Framework as a potential impact-assessment framework, and S-D logic as a new perspective to bridge the gaps between citizen science and the Payback Framework. Subsequently, the theory-adaptation approach is described briefly and applied. From this, a Citizen Science Payback Framework (CSP Framework) based on the Payback Framework and enriched by S-D logic is presented and advocated. Finally, the theoretical and practical implications of the proposed model are discussed in detail; limitations and future research avenues are also highlighted.

CITIZEN SCIENCE

Citizen science can be defined as "the participation in scientific processes of people who are not institutionally involved with a specific field of science" (Bonn et al. 2016, p. 13). This definition of citizen science is generally accepted, but the degree of citizen involvement varies. For some academics, the term means public participation in scientific research; these scholars understand partnerships between citizens and scientists to be opportunities to create and handle large datasets. For others, citizen science is a move toward a scientific democracy in which

citizens and scientists engage as equal partners in research projects (Bonney et al. 2016).

One approach to differentiating among citizen science projects focuses on the power and control of the different actors in the research process (Bonney et al. 2009). Bonney et al. (2009) established three models for public participation, viewed as three stages with increasing power allocated to citizens. The first stage entails contributory projects, i.e., projects designed by scientists in which citizens contribute data primarily. The second stage presents collaborative projects, which, in addition to the responsibilities of contributory projects, also allow citizens to assist in specific research steps. Finally, the third stage comprises co-created projects, designed jointly by scientists and citizens, in which citizens participate in most, ideally all, project steps (Bonney et al. 2009). Bonn et al. (2016) extended this differentiation by adding another (base) stage, in which citizens are passive observers whose sole contributions, if any, are to communicate ideas.

PAYBACK FRAMEWORK

Over the past few decades, many evaluation methods have been developed to capture the social impact of research (Smit and Hessels 2021). These evaluation methods differ in their assumptions of, e.g. actor roles, interaction mechanisms, concept of societal value and their understanding of the relationship of societal and scientific value (Smit and Hessels 2021). A few of the most notable models are, for example, the Social Impact Assessment Methods for research and funding instruments through the study of Productive Interactions (SIAMPI), the Australian Research Quality Framework (RQF), and the Payback Framework (Penfield et al. 2014).

The Payback Framework is one of the most commonly used methods to assess the impact of research projects beyond academic impact and was developed by Buxton and Hanney in 1996 in the field of health (Greenhalgh, Raftery, Hanney and Glover 2016; Milat, Bauman and Redman 2015). Since its creation, the Payback Framework has been applied multiple times and adapted and used in areas other than health services, including social sciences (Klautzer et al. 2011) and arts and humanities (Levitt et al. 2010). It was adopted by institutions such as the Canadian Institute of Health Research, the Dutch Public Health Authority, the Australian National Health and Medical Research Council, and the Welfare Bureau in Hong Kong (Penfield et al. 2014). Furthermore, the Payback Framework functioned many times as the basis or inspiration for other evaluation methods like the Contribution Mapping and the Impact Narratives, which presents one part of the Research Evaluation Framework (REF) for U.K. higher education institutions (Smit and Hessels 2021).

The reasons for the framework's popularity are numerous. The underlying theory of the Payback Framework is conceptually beneficial as it premises that by generating and sharing knowledge, research exerts influence (Belcher et al. 2020). The framework comprises the complete research process and links the research stages and the impact generated, thus describing how impact occurs (Penfield et al. 2014). It is a tool that collects data and provides a common structure for evaluating case studies and conducting cross-case analyses flexibly and intuitively (Donovan and Hanney 2011; Searles et al. 2016).

We have chosen the Payback Framework also as a basis for our framework for citizen science social innovation projects, not only because it is regarded as the best practice approach for impact assessment, and it can be adapted easily (Bornmann 2013; Donovan 2011; Pen-

field et al. 2014), but mainly because it combines the evaluation of the whole project process represented by the *logic model* and various impact categories presented in a *classification system* that captures five dimensions of benefits: knowledge, research benefits, political and administrative benefits, health sector benefits, and broader economic benefits (Donovan and Hanney 2011). It is widely accepted that the evaluation of research should consider the whole process and not only the outcomes (Schaefer et al. 2021), which is especially true for participatory evaluation in which the involvement of stakeholders varies in the different project phases (Springett 2017). In addition, the classification of the impact categories is sufficiently differentiated to cover all possible impacts but broadly enough to cover the wide range of social innovation projects. The two components of the Payback Framework are discussed below in more detail.

The logic model consists of seven stages (stages 0–6) and two interfaces. Figure 1 presents a graphical presentation of the model (Donovan and Hanney 2011). The seven stages assume an input-output perspective and delineate the underlying research project from its initial inception (stage 0) to its final outcome (stage 6) (Buxton and Hanney 1996; Donovan and Hanney 2011). The two interfaces are: 'Interface A: Project specification, selection, and commissioning' and 'Interface B: Dissemination, connecting the project with its environment, and embodying the interaction between researchers and potential users' (Greenhalgh et al. 2016). Feedback loops within the model ensure that the nonlinear processes of projects are considered (Greenhalgh, Raftery, Hanney and Glover 2016).

The classification system describes assessed benefits. The five dimensions from the original Payback Framework used for health research are two traditional academic-benefit dimensions: knowledge (e.g., academic publications) and research benefits (e.g., training new researchers). The other three dimensions of this study's model are related to broader societal benefits: political and administrative benefits (e.g., an information base for clinical policies), health sector benefits (e.g. cost savings), and broader economic benefits (e.g., commercial spin-outs) (Buxton and Hanney 1996; Donovan and Hanney 2011; Greenhalgh, Raftery, Hanney and Glover 2016). Benefits can arise at all stages of the logic model. However, some broad connections between stages and benefits exist; for example, benefits relating to broader societal benefits appear more often at later stages (Donovan and Hanney 2011).

It should be noted that when the Payback Framework is utilised in other areas, the health-related dimensions of the classification system, the second component of the model, must be modified (Klautzer et al. 2011). Adapting the Payback Framework to employment research, Klautzer et al. (2011) proposed to generalise the framework to the social sciences; the primary adaption was to substitute 'impacts on practice' for 'health sector benefits'. Despite adaptions for various sectors and projects, the application of the Payback Framework has been observed to retain most of its original structure and elements (Donovan and Hanney 2011).

Despite the framework's comprehensive and extensive approach and adaptability, limitations to its application and output exist. It has been criticised as labour-intensive and too project-focused (Greenhalgh et al. 2016). Furthermore, it is claimed that the complexity and interactive variables of research lead to a more sophisticated relation between inputs and outputs than it is presented in the framework (Pedersen 2020) and that the model does not capture factors like attitudes, skills, and relationships (Belcher et al. 2020). Moreover, when evaluation is performed by academics only, the process overlooks other relevant actors' impact as-
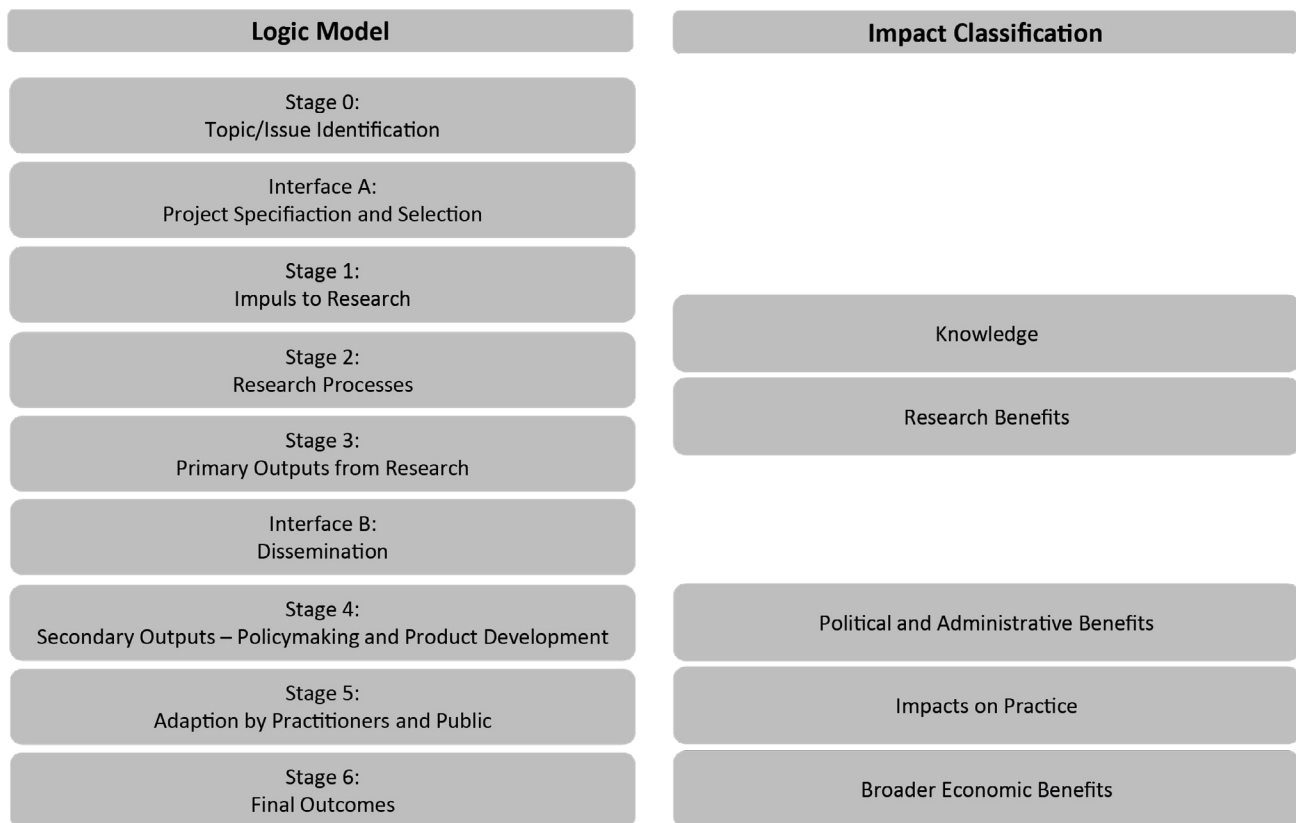
Logic Model	Impact Classification
Stage 0: Topic/Issue Identification	
Interface A: Project Specifiaction and Selection	
Stage 1: Impuls to Research	**Knowledge**
Stage 2: Research Processes	**Research Benefits**
Stage 3: Primary Outputs from Research	
Interface B: Dissemination	
Stage 4: Secondary Outputs – Policymaking and Product Development	**Political and Administrative Benefits**
Stage 5: Adaption by Practitioners and Public	**Impacts on Practice**
Stage 6: Final Outcomes	**Broader Economic Benefits**

Figure 1: Logic Model and Impact Classification of the Payback Framework | Source: Authors' illustration based on Donovan and Hanney (2011)

sessments and experiences. This limitation has led some researchers to seek additional perspectives by conducting supplementary, semi-structured interviews with relevant actors, such as users or patients (e.g., Guthrie et al. 2015; Klautzer et al. 2011). Furthermore, while the Payback Framework's process, with its feedback loops, incorporates the non-linearity of projects, non-linearity is not accounted for in how knowledge is exchanged and generated between actors. Mainly for applications in social sciences and the humanities, the framework has been criticised for assessing the exchange of knowledge between HEIs and society too simply, instead of viewing it in a holistic network of actors and institutions as well as their complex interests and values (Belcher et al. 2020; Pedersen et al. 2020).

THEORY ADAPTATION: LOOKING AT THE PAYBACK FRAMEWORK THROUGH AN S-D LOGIC LENS

Although the Payback Framework is a commonly accepted framework for research projects, its academic focus and linear understanding of knowledge transfer limit its appliance to citizen science projects for social innovation. This study's use of the theory-adaptation approach aimed to overcome these limitations by introducing another theoretical lens to an existing theory, the holistic lens of the Service-Dominant logic (Jaakkola 2020). In this case, the existing theory, referred to as domain

theory, was the Payback Framework, while S-D logic served as the 'new' lens, called method theory. By integrating the co-creative, interactive nature of S-D logic, the observed gaps of the Payback Framework could be bridged, and its application domain extended to citizen science projects for social innovation.

In this study, the first step of the theory-adaptation process was to understand the lens of S-D logic and its applicability to the field of citizen science. S-D logic emerged in 2004 when Vargo and Lusch challenged the traditional view of creating value. S-D logic presents a continuing narrative of value co-creation that is applied in various academic disciplines, for example, in innovation research (Vargo and Lusch 2017). In the traditional marketing view, the firm creates and delivers value in the form of goods and services. S-D logic describes all actors, including the firm and the customers, as equal actors creating value through interaction and collaboration (Jaakkola and Alexander 2014; Vargo and Lusch 2004). Since this understanding of all resource integrators as equal actors overcomes the distinction of producer and consumer, the value creation process is defined as a co-creation process (Vargo and Lusch 2004).

Transferring this perspective to academia and social innovation projects makes it applicable to citizen science, a field characterised both by the increasing participation of previously non-involved and non-engaged actors in academic projects and by the degree of power allocated to those actors. Following S-D logic, academia can be equated to firms that create value within and beyond the scientific sector in a co-creation process with citizens.

Resources are a central concept in S-D logic. Following the resource-based view of value creation, resources are defined as anything that ena-

bles an actor to create value. Resources are integrated into the process of co-creation (Vargo and Lusch 2008). However, in S-D logic, resources are not only physical but are also intangible, including, for example, knowledge and skills (Vargo and Lusch 2008). In S-D logic, actors play underlying roles as resource integrators; that is, actors, bring together their unique resources to create value. Resource integration is shaped by actors' knowledge, skills, intentions, and motivation (Edvardsson et al. 2014). A similar resource-integration practice can be seen in citizen science projects, benefiting the projects significantly. Academic actors bring in academic resources (e.g., material equipment, but also theoretical knowledge and methods), while non-academic actors contribute non-academic resources (e.g., practical knowledge, needs, and experiences).

Recently, there has been a growing understanding that no co-creation process occurs in isolation; the process always occurs within nested and interlocking service ecosystems (Vargo and Lusch 2016). Vargo and Lusch (2016, p. 161) define a service ecosystem as a 'relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange'. Through the lens of S-D logic, institutions, sectors, or disciplines present different ecosystems that can overlap and build a complex and interrelated resource-integration arrangement around a purpose, namely the innovation process (Vargo and Lusch 2016). In citizen science projects for social innovation, these ecosystems may encompass HEIs, on the one hand, and segments of cooperative society, on the other hand. Considering the innovation process from an S-D logic perspective implies that a project's ecosystems offer the relevant structures for actors as resource integrators and value co-creators within the innovation process (Aal et al. 2016).

In summary, S-D logic provides a promising holistic and dynamic lens to understand and describe the participatory nature of citizen science since it overcomes the distinction between producer and user by describing all participants as resource integrators who co-create value. The focus on the actors as resource integrators captures the collaborative way in citizen science social innovation projects, in which academics and citizens collaborate to co-create a social innovation to overcome social challenges.

In the second step of the theory-adaptation process within this study, S-D logic was applied to the Payback Framework to address the two known limitations of its applicability to citizen science projects, identified previously as the framework's purely academic view on impact evaluation and its linear knowledge generation. The understanding of all participants of the collaboration process as equal actors who are integrating their resources, the S-D logic allows overcoming the linear knowledge transfer conceptualisation of the Payback Framework to reflect the current co-creation approach of knowledge generation in academia (Greenhalgh et al. 2016). This holistic approach can not only be applied to the knowledge generation but also to the evaluation process, aiming for a participatory evaluation understanding (Springett 2017).

The two pre-existing components of the Payback Framework (the logic model and the benefit classification system) do not adequately represent the participatory approach of citizen science and the co-creative nature of S-D logic. Therefore, a third component of the Payback Framework was introduced: the level of citizen participation. This new component was added to evaluate the degree of citizen participation in the logic model's activities to indicate the citizens' participation in the evaluation process.

The citizen participation component in the new framework has direct links to each stage of the logic model and Interface A (Project specifica-

tion and selection) and Interface B (Dissemination). At each stage of the logic model (including Interface A and Interface B), the extent to which citizen participation is enabled within the project is specified, allowing for an individual, stage-specific description of citizen participation in each project. The evaluation of citizen participation is made by judging the intensity of current participation compared to the maximum participation possible (equalisation of the actors – how it is conceptualised in the S-D logic). There are four potential levels of citizen participation in a project: *no participation*, *contribution*, *collaboration*, and *co-creation*. These levels were defined according to the four stages of citizen participation in the research process of citizen science projects and were differentiated by the amount of power and control given to the participating non-academic actors (Bonn et al. 2016; Bonney et al. 2009). The definitions account for the fact that non-academic actors can be differently engaged in the stages of the Payback Framework's logic model. Once all stages of a project have been evaluated, a general evaluation of citizen participation can be achieved by considering the overall degree of citizen participation in the project.

The four levels of citizen participation have different implications. Generally, with growing allocated power and participation, non-academic actors gain more awareness, knowledge, and understanding of the project (Bonney et al. 2009). Thus, (0) *no participation* implies that the old Payback Framework structure with its academic perspective and unidirectional knowledge generation is retained. (1) *Contribution* means that a limited degree of participation is present, i.e., non-scientific actors gathering data and information. (2) *Collaboration* of non-academic actors implies that they participate to a moderate degree, perhaps by analysing data or disseminating societal outputs. Finally, (3) *co-creation* means that non-academic partners are actively involved and participate fully in the project as equal partners. Depending on the level of participation, the citizens should be included in the evaluation of the project stage in various manners, from specifying the purpose of the evaluation, formulating the evaluation question, collecting the data, interpreting the data, and acting on the results (Springett 2017).

The described CSP Framework is presented in Figure 2. The Figure highlights the interplay of the framework's three components, with the evaluation of external participation on the left as a starting point, the logic model at the heart of the framework, and the benefit dimensions on the right, positioned close to where they are most likely to arise.

The proposed CSP Framework benefits from its comprehensive yet inclusive structure. It utilises the process steps of the logic model of the Payback Framework, as well as the application of its impact categories and considers non-academic actors and their contributions at all possible stages of the process. The new framework enables a citizen science project's holistic and inclusive evaluation and categorisation based on actual levels of citizen participation.
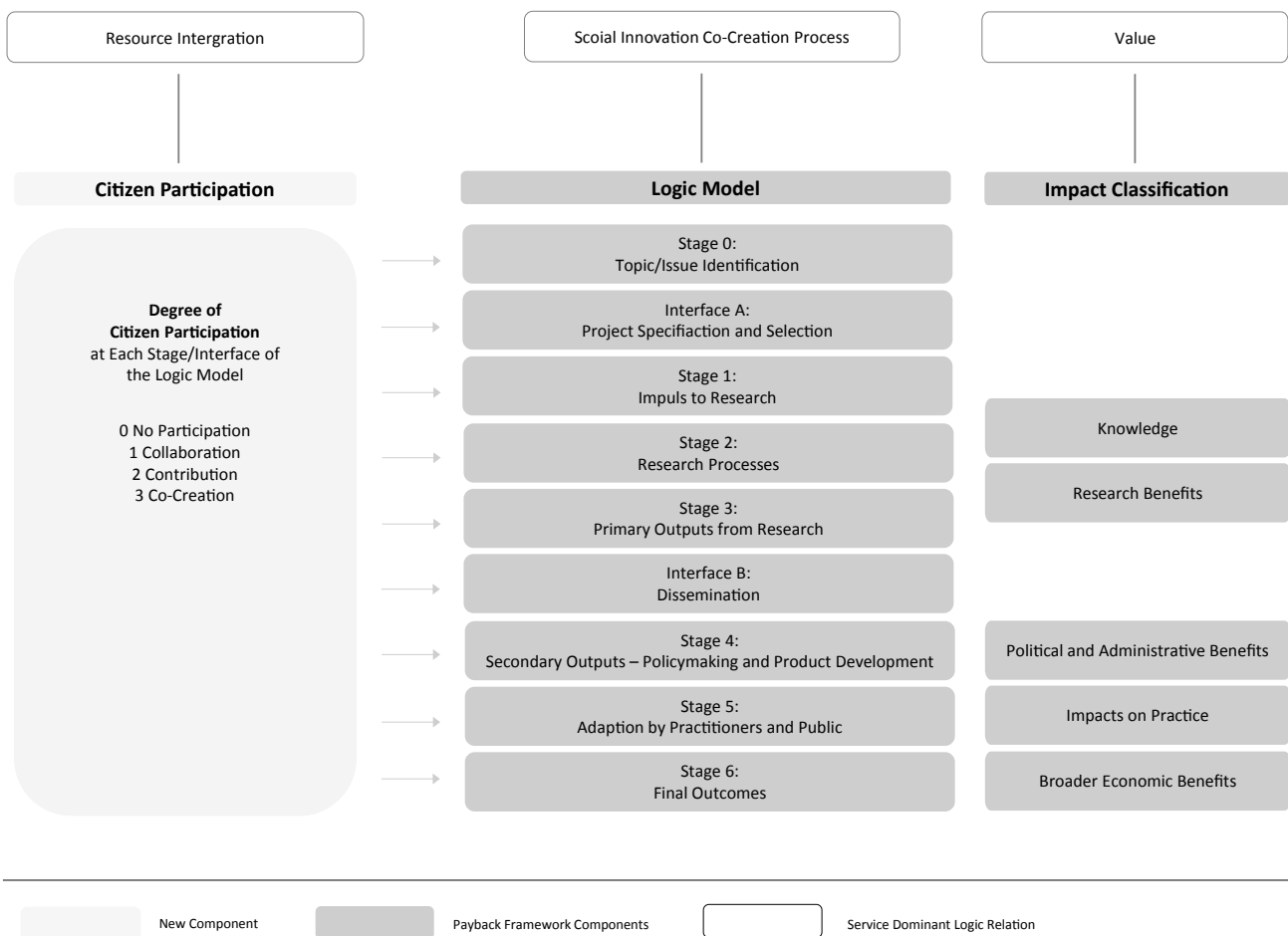
Resource Intergration	Scoial Innovation Co-Creation Process	Value

Citizen Participation	Logic Model	Impact Classification

Degree of Citizen Participation at Each Stage/Interface of the Logic Model

0 No Participation
1 Collaboration
2 Contribution
3 Co-Creation

Stage 0: Topic/Issue Identification

Interface A: Project Specifiaction and Selection

Stage 1: Impuls to Research

Stage 2: Research Processes

Stage 3: Primary Outputs from Research

Interface B: Dissemination

Stage 4: Secondary Outputs – Policymaking and Product Development

Stage 5: Adaption by Practitioners and Public

Stage 6: Final Outcomes

Knowledge

Research Benefits

Political and Administrative Benefits

Impacts on Practice

Broader Economic Benefits

New Component   Payback Framework Components   Service Dominant Logic Relation

Figure 2: Citizen Science Payback Framework (CSP Framework) | Source: Authors' illustration

CONCLUSION

THEORETICAL CONTRIBUTIONS

The study contributes to the existent academic literature in the fields of evaluation and citizen science. Notably, it demonstrated how the frequently exerted Payback Framework could be extended to apply to citizen science projects for social innovation. The expansion was accomplished using the theory-adaptation approach. This approach creates academic value by connecting different academic fields of knowledge (Jaakkola 2020). The Payback Framework originates in health science, while S-D logic is part of marketing theory. While both the Payback Framework and S-D logic have been applied in various academic fields, to our knowledge, this study is the first to apply them jointly in the area of citizen science. The study demonstrated how the co-creative nature of S-D logic enriches the previously purely academic focus of the Payback Framework and allows for consideration of the dynamic knowledge generation between different actors.

The resulting conceptual CSP Framework, with its third component, introduces a participatory evaluation and impact assessment model for citizen science projects for social innovations and contributes to the the-

oretically and conceptually underdeveloped field of participatory impact evaluation (Smit and Hessels 2021; Springett 2017).

PRACTICAL IMPLICATIONS

Adaptations that have resulted in the proposed CSP Framework offer two potential applications for practitioners. First, the CSP Framework can be used to compare projects and proposals. There is still no one-size-fits-all model (Greenhalgh, Raftery, Hanney and Glover 2016), but with a similar structure and benefit dimensions as the Payback Framework, the CSP Framework makes possible comparisons of citizen science projects for social innovation that vary in implementation and scope. Comparisons through the CSP Framework have the potential to justify public funding and support for academic projects (Bornmann 2012; Greenhalgh, Raftery, Hanney and Glover 2016), thus creating a further incentive for academic actors to create more societally relevant projects and to include non-academic actors in projects. Second, the framework can evaluate citizen science projects for social innovation using a defined structure. Looking to the future, a more co-creative evaluation process may influence projects in the long term. As project evaluations influence and determine the projects that are pursued in

the present and future by creating incentives and guidelines, a participatory approach to the evaluation process may make the entire project focus itself more participatory. As proposed in the S-D logic and the innovation and participatory evaluation, this contribution assumes that higher participation of citizens leads to better project processes and outcomes (Senabre Hidalgo et al. 2021; Vargo and Lusch 2017), but this might not be applicable in all citizen science projects.

FUTURE RESEARCH AND LIMITATIONS

Although the S-D logic offers a holistic and inclusive perspective to overcome the limitations of the Payback Framework and captures the participatory nature of citizen science, by utilising the understanding of a co-creative resource integration process of various actors leading to value generation, the extension of the framework by the new component could be considered as superficial. How the citizens' participation can be evaluated and how exactly they could be included in the evaluation process remains unclear. The S-D logic as a macro theory must be enhanced by a bridging micro theoretical approach for a more precise conceptualisation. Nevertheless, not only a further and more detailed conceptualisation of the model is needed, the model should be empirically tested and thus operationalised in a further step. The merely theoretical conceptualisation of the model could have led to critical issues being overlooked that may surface in the operationalisation phase and the practical application. While the study's proposed CSP Framework allows citizens to be part of the project evaluation process, it does not yet include an assessment of the success of co-creative practices and evaluation factors like trust and relationships (Belcher et al. 2020). The new component captures the extent of the citizen participation, but the contribution of the interaction, rather than its attribution, must be considered further (Spaapen and van Drooge 2011). Another task for future research may be to determine if the CSP Framework can be applied to all citizen science projects and not simply to those for social innovation. Innovation projects are characterised by the collaboration of various actors from different sectors, but this does not apply to other citizen science projects. Here it should be determined whether the model is also applicable to other citizen science projects or should be modified accordingly.

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