Codesign in resource-limited societies: theoretical perspectives, inputs, outputs and influencing factors

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Abstract

Codesign with resource-constrained people living in developing countries is crucial for sustained adoption and use of designed solutions. Several studies have investigated codesign with resource-constrained people. It is, therefore, important to understand what has been investigated and learnt so far as well as to plan for further scholarly exploration of this field. To address this, I applied a systematic literature review (SLR) approach to understand main sources, definitions, and theoretical perspectives regarding codesign with resource-constrained people. The SLR also aimed to understand inputs and outputs of codesign as well as factors influencing the codesign process. The findings portray a multifaceted picture regarding these aspects of codesign. I discuss implications of review findings for the practice of codesigning solutions with resource-constrained people, identify concerns that researchers should have about this field, and offer suggestions for future research in this field of codesign.

Keywords Design process · Cocreation · Participatory design · Developing countries · Low resource settings · Frugal innovation

1 Introduction

Ten percent of the world's population subsisted on less than 1.90 US dollars per day in 2015 (World Bank 2019). Problems faced by the resource-constrained people living in developing countries are typically multidimensional. Their problems have been framed in many varied ways such as a monetary issue (Banerjee and Duflo 2007), ill health, or inability to fulfil basic needs (Karelis 2007). Their problems share many intertwined attributes such as lack of income and resources for satisfying basic needs such as food, shelter, and clothing, and weak or non-existent access to basic facilities such as energy, education (Gustavsson 2007), sanitation (Lopes et al. 2012), public health (Zurovcik et al. 2011), safe drinking water (Matlack et al. 2011), and infrastructure (Prahalad 2004). The resource-constrained people also face social, cultural, and political exclusion. They typically suffer from psychological stress due to illiteracy and

innumeracy, and fatigue from physical labour (Nakata and Weidner 2012a, b).

Design, with its central idea of changing an undesired situation into a desired situation (Simon 1996), is profoundly crucial to satisfy needs of resource-constrained people in developing countries (Papanek and Fuller 1972). Appropriately designed solutions can potentially create a significant impact, supporting social and human development of resource-constrained individuals and societies (e.g. Schumacher 1973; Donaldson 2006). Such solutions can manifest in the form of products and services such as medical devices, smokeless cookstoves, income-generating products and services, agricultural equipment, communication devices, solutions providing access to energy, water and sanitation facilities, solutions for delivery of education, facilities promoting entrepreneurial activities, programmes raising awareness about environmental issues, or any other solutions that promote development of resource-constrained individuals and communities (Aranda Jan et al. 2016; Prahalad 2004).

The idea of harnessing the power of design to support development of resource-constrained individuals and communities can be traced back at least to the 'Design for the Real World' movement initiated by Victor Papanek in the 1970s (Papanek and Fuller 1972). In 1998–1999, C. K.

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Prahalad and his colleagues articulated an approach, typically known as the Base of the Pyramid (BOP) approach, in which they suggested that companies can design appropriate products and services for people living at the base of the world income pyramid (i.e., Base of the pyramid—BOP), creating a win–win scenario—raising profits and addressing needs of resource-constrained people (Prahalad and Hart 1999; Prahalad and Lieberthal 1998). Several studies have identified factors that motivate companies to design solutions for resource-constrained people (e.g. Hammond and Prahalad 2004; London and Hart 2004; Govindrajana and Winter 2015; Govindarajana and Trimble 2012).

Most of the extant academic literature on design is anchored in the context of Western countries and relatively wealthy regions. Since, context is important in designing solutions (Subrahmanian et al. 2020; Mattson and Wood 2014; Jagtap 2019a) and because there are significant economic and socio-cultural disparities between resource-constrained societies and developed countries, there are substantial differences between factors affecting success of products and services in these significantly different contexts (Aranda Jan et al. 2016; Prahalad 2004; Jagtap et al. 2013). Codesign with resource-constrained people is a crucial factor in determining success of products and services in the context of resource-constrained societies (Jagtap 2020). Externally designed solutions, without involving resource-constrained individuals in design and development activities, might fail to satisfy many varied requirements and constraints in resource-constrained societies (e.g. Nieusma 2004; Dodson et al. 2012; Thomas 2006). Remotely designed solutions might not create desired impact on social and human development of resource-constrained individuals and communities. Codesign, with its non-paternalistic and inclusive nature, enhances adoption and continual usage of products and services by resource-constrained individuals.

Although codesign research has been undertaken mainly in Western countries or relatively wealthy markets in developing countries, many studies investigating codesign have been carried out in resource-limited societies (Tomico et al. 2012; Dayaratne 2016; Ambole et al. 2019; Jagtap 2021a, b). This research on the involvement of resource-constrained people in design and development activities is discussed using names such as codesign, cocreation, and participatory design (Puri and Sahay 2003; Sell et al. 2018; Ambole et al. 2019; Silva et al. 2020; Jagtap 2021a, b). Codesign with resource-constrained people is considered important in the literature on ‘appropriate technology’, ‘humanitarian engineering’, ‘design for extreme affordability’, ‘community development engineering’, ‘design for development’, and ‘frugal innovations’ (Jagtap 2019a). In addition, interest in this field has grown over the past decade, potentially stimulated by the Millennium Development Goals and in recent years by the Sustainable Development Goals of the

UN (e.g. UN 2021). Moreover, several universities and institutes around the World are providing opportunities for undertaking design research in this field (Jagtap et al. 2014; Bursleson et al. 2020). Whilst there are many studies investigating involvement of resource-constrained people in design activities, their analysis is lacking, making it difficult to gain an overview of how codesign with the resource-constrained has been defined in the literature, various theoretical perspectives on codesign processes in this field, and different types of sources initiating codesign activities with resource-constrained people in developing countries. I address these issues by applying systematic literature review approach. In the systematic literature review, I also adopt a broadly accepted input-process-output (I–P–O) framework (Ghezzi et al. 2017) to scrutinise and explore inputs, success factors, impeding factors, and outputs of codesign processes—all these aspects are important in carrying out design research in this domain as well as in devising and assessing methods to support codesign with resource-constrained people for enhancing their social and human development.

As such, this paper aims at systematically reviewing: (1) how codesign with resource-constrained people has been defined in the literature, (2) theoretical perspectives on codesign in this field, (3) sources initiating codesign activities with resource-constrained people, (4) factors supporting and hindering codesign with them, (5) inputs in codesign activities, and (6) outputs of codesign. In addition to the above aims, I identify crucial areas that are not yet explored, draw attention to concerns that researchers ought to have, and provide novel insights on codesign literature in this field. As such, the article contributes towards an improved understanding of ways in which research about codesign with resource-constrained people can be undertaken. My purpose is to support this field to explain some of its current issues, and to suggest further areas for scholarly exploration of this field.

Following this introduction, the rest of this paper is organised as follows. Section 2 presents details of the review methodology. Section 3 synthesises the reviewed literature, presenting the review findings. Finally, Sect. 4 presents limitations and offers recommendations for future research avenues. As such, the paper will be useful to those who are new to this field as well as to those who are experts in this field.

2 Methodology

I applied systematic literature review (SLR) approach (Tranfield et al. 2003; Snyder 2019) to address the research aims. The SLR approach permits structured selection of research articles, preventing arbitrary collection of random articles and maintaining transparency in the methodology (e.g. Snyder 2019; Jagtap 2019b; Seuring and Müller 2008; White

and Schmidt 2005). The SLR approach organises the review employing steps such as formulation of review aims, searching for research papers based on the review aims, selecting and excluding papers, and analysing the selected papers (Tranfield et al. 2003). Following such steps, I selected papers for review using multistate, structured procedure after formulating the need and review aims as discussed previously in the introduction section. The steps in the SLR as applied in this research are elaborated in the paragraphs that follow.

Scopus and Web of Science are major well known and large bibliometric databases of peer-reviewed articles, consisting of a broad range of publications such as journal articles, conference papers, and book chapters (Prasara-A and Gheewala 2017). I, therefore, employed these databases for searching the literature. Recent SLR studies have employed one or both of these databases for literature search (Roy and Singh 2017; Jagtap 2019b).

In searching for the literature in Scopus and Web of Science databases, I included either the article title, abstract, or keywords as search field, and did not impose any date limitations. Although I decided to primarily include journal articles to address concerns regarding article quality, I also considered conference papers as well as book chapters taking into account their relevance for the review aims. The subject of codesign with the resource-constrained people has been published in many document types in Scopus and Web of Science, potentially reporting crucial knowledge relevant for codesign in this field and for addressing the aims of the review. Likewise, since the research in this field is carried out by scholars from many varied disciplines, I did not apply any restrictions on subject areas in the databases.

I used many search terms to search for literature in the databases. Appendix 1 presents the full list of search terms used in this research. The search terms used in this review primarily included combination of two categories of terms. The first category of terms is related to the aspects of codesign or involvement of resource-constrained people in design and development activities, and included terms such as “codesign”, “cocreation”, “participatory design”, etc. The second category of terms is related to poverty and poor

people, consisting of terms such as “poverty”, “base of the pyramid”, and “poor people”. Each term in the first category was combined with each term from the second category by employing the Boolean operator ‘AND’. In total, 42 searches were carried out using such combinations of terms from the 2 categories.

I have used a large number of search terms, focussing on the review aims which are about codesign with the resource-constrained people in developing countries. I did not include search terms such as “developing countries”, and “global south”, as they include middle class as well as high-income people, thus leading to articles that are irrelevant for addressing the review aims. Likewise, I did not use terms such as “social innovation” as they focus on developing as well as developed countries, and include middle- and high-income people, resulting into search outcomes that are irrelevant for addressing the review aims. Furthermore, I did not add a third term such as “innovation” in the combination of search terms (e.g. “base of the pyramid” AND “codesign” AND “innovation”) because the resulting articles would have been included in the existing combination of search terms, for example, in the search results of the combination—“base of the pyramid” AND “codesign”. The search terms such as “base of the pyramid” and “bottom of the pyramid” include low-income and resource-constrained people in developing countries. The search terms and the 42 searches that I have employed in the SLR were not only appropriate for addressing the review aims, but also made the review feasible.

The 42 searches in each of the 2 databases resulted into 266 articles. Of these 266 articles, 85 were duplicates and were excluded, resulting into 181 unique articles. Following this stage of the SLR, I assessed these 181 unique articles, and omitted articles that were considered irrelevant for the present study. This is in line with previous studies employing SLRs (e.g. Prasara-A and Gheewala 2017; Hossain 2018; Jagtap 2019b). I omitted 120 articles which were deemed irrelevant for addressing the aims of the review, and selected 61 articles after ensuring their appropriateness for addressing the review aims. Table 1 presents the criteria used for article selection and de-selection, along with additional review parameters. Some articles were omitted because they

Table 1 Review parameters

Review parameter	Description
Search agents	Scopus and Web of Science
Article type	All document types in Scopus and Web of Science (e.g. articles, conference papers, and book chapters)
Search fields	In article title, abstract, and keywords
Article selection criteria	An article should be relevant for addressing the aims of this review. Therefore, only those articles are considered, which reflect a focus on the codesign, co-creation, or participatory design with resource-constrained people in developing countries
Article de-selection criteria	The articles not relevant for addressing the review aims were eliminated. Furthermore, the articles with just a tangential reference to design with resource-constrained people were de-selected

tangentially referred to codesign with resource-constrained people in developing countries, and were not appropriate for addressing the review aims. Likewise, some articles were omitted as they focused on developed country contexts.

I eliminated about 66% of 181 articles. This is because an SLR aims at addressing prespecified aims, and therefore only articles that are relevant for addressing the SLR aims are selected by applying criteria for selecting and de-selecting articles (Snyder 2019). As such, the percentage of articles eliminated in an SLR is typically high. For example, in many SLRs greater percentage of the articles has been eliminated after applying article selection/de-selection criteria (for example, see the SLRs by Prasara-A and Gheewala 2017; Roy and Singh 2017; Jagtap 2019b).

As the review progressed, I identified further eight articles that were either cited in the reviewed articles or were found in the process of searching for details of some information in the reviewed articles, and were deemed appropriate for consideration in this review. As such, I reviewed 69 (i.e. 61 + 8) articles in total.

As discussed previously, the SLR approach organises the review by following a systematic step-by-step approach involving formulation of review aims, searching for articles informed by the review aims, selecting and de-selecting articles, and analysing the selected articles to address the review aims. As such, the review aims inform the analysis of selected articles (e.g. Tranfield et al. 2003; Snyder 2019; Hossain 2018). In the present review, the review aims which are discussed previously in Section ‘Introduction’, formed a basis for the analysis of selected articles. The selected articles were analysed to address the review aims regarding how codesign with resource-constrained individuals has been defined in the literature, various theoretical perspectives about codesign in this field, different types of sources initiating codesign activities with resource-constrained people, inputs and outputs of codesign, and factors supporting and hindering codesign in this field.

I analysed each of the selected articles, thoroughly reading the articles and highlighting content that was relevant for addressing the review aims. This is a common approach followed by review papers using SLR approach (Snyder 2019; Hossain 2018). The review aims and the I–P–O framework associated with the review aims (see Fig. 1) informed the analysis process. The I–P–O framework has been applied in several studies from multiple disciplines (e.g. Simsek 2009; Ghezzi et al. 2017; Hossain 2018), and provides a basis for identification of inputs, outputs and factors supporting or hindering the phenomena under study. Previous studies have used the I–P–O framework for systematic reviews of literature, supporting authors to systematically review and interpret the literature (Ghezzi et al. 2017). In adopting the I–P–O framework, I have taken into account supporting and hindering factors as two main aspects of the process

Fig. 1 The I–P–O framework

component of the framework, in line with the SLRs that have used this framework.

Pre-specified review aims about codesign definitions, theoretical perspectives about codesign, sources of codesign, factors supporting or hindering codesign, etc. provided a basis for the analysis of papers. For example, definitions of codesign or involvement of resource-constrained people in design activities were categorised under the theme ‘definitions’. Models, theories, and frameworks of codesign discussed in the articles were categorised under the theme ‘theoretical perspectives’. Sources initiating codesign activities were categorised under the theme ‘sources’ of codesign. These sources mainly include researchers, companies, and social enterprises. In a similar fashion, inputs and outputs of codesign activities were used as categories to classify relevant knowledge into these categories. Likewise, factors supporting or hindering codesign processes with resource-constrained individuals were categorised under the themes ‘success’ factors and ‘hindering’ factors. All text and memos taken throughout the analysis process were synthesised to map the codesign literature in this field. Next section presents these synthesised findings of the review.

3 Findings

This Section presents findings of the review. These findings address the reviews aims about how codesign with the resource-constrained people has been defined in the literature (Sect. 3.1), various theoretical perspectives about codesign in this field (Sect. 3.2), different types of sources initiating codesign activities with resource-constrained people (Sect. 3.3), inputs and outputs of codesign (Sects. 3.4 and 3.5), and factors supporting and hindering codesign in this field (Sects. 3.6 and 3.7). As such, this section is structured to present findings related to the review aims.

3.1 Definitions and terms

Involvement of resource-constrained people in design and development of solutions has been defined or described in many ways and terms, offering various perspectives on the integration of knowledge and capabilities of relevant partners (Rosca and Bendul 2016). For example, whilst some studies use the term co-creation (Hernandez-Cazares et al. 2019; Dalvit et al. 2013; Funamizu 2017; Galafassi et al. 2018), others employ terms such as codesign or participatory design (Zeb et al. 2019; Nthane et al. 2020; Mwanzia and Misati 2013), emphasising involvement of resource-constrained people or a broad range of partners for sharing information or for offering suggestions in the design and development process to realise value for the involved stakeholders, including resource-constrained people (Bharti 2014, Rosca and Bendul 2016; Jagtap and Larsson 2019).

Nahi (2016), for instance, defines cocreation in the context of resource-constrained communities in developing countries as “iterative interaction that empowers resource-constrained communities and integrates their knowledge and capabilities with those of a company and other actors” throughout the process of designing solutions. Another example of offering definition of cocreation in this field is the study of Bharti et al. (2014), who define cocreation as “the joint collaborative activities by parties involved in direct interactions aiming to contribute to the value that emerges for one or both parties”. In a similar fashion, Sun and Im (2015) describe cocreation as generation of both social and economic values. They consider cocreation as the process, undertaken by various stakeholders, to collaboratively identify, define and solve social problems by selecting and combining resources, with the intention of generating social plus economic values. Some authors also consider cocreation as cross-sector collaboration, involving joint activities between resource-constrained people, for-profit organisations, NGOs and governments (Hou 2017; Jagtap and Larsson 2019).

Process-based perspectives of cocreation suggest that value can be created at the customer end, at the organisation end, and/or during the interaction between customers and organisations (e.g. Payne et al. 2008). Many studies typically focus on value creation induced by organisations and/or generated during the interaction between organisations and customers. In contrast to these typical perspectives, Dey et al.’s (2016) study has explored value creation at the customer end, i.e. value creation by resource-constrained people.

The above perspectives on cocreation, potentially influenced by the authors’ disciplinary backgrounds and specific aims of their studies, show some differences between them. For example, Dey et al.’s (2016) study, focussing on how resource-constrained individuals use products, consider cocreation as a process of generating value through interaction between resource-constrained individuals. However,

whilst there are some differences in how cocreation is defined or explained, it is typically considered as involvement of resource-constrained people and a diverse range of stakeholders such as companies, NGOs and local governments in the process of creating solutions to generate value for the involved partners, including resource-constrained individuals and communities. A central aspect of cocreation in this field is about the interactive process of exploration, recognition, and integration of knowledge, resources and capabilities of resource-constrained individuals and other relevant organisations. For example, whilst companies typically contribute in the cocreation process with their resources and knowledge about technology and markets, local actors such as resource-constrained people and NGOs bring their capabilities and knowledge about local needs, available resources, and networks (e.g. Nahi 2016; Murphy et al. 2012). In addition, NGOs connect companies to local communities and actors by facilitating and organising workshops and meeting (Jagtap and Larsson 2019; Nahi 2018).

In addition to the term ‘cocreation’, involvement of resource-constrained people in design activities has also been defined or described by employing the term ‘codesign’. For instance, Jagtap (2021a, b) refer to codesign not just as actual interaction between designers and resource-constrained individuals, but also as accomplishment of tasks such as planning to involve resource-constrained people in design activities, organising and managing their continued involvement in the project, and implementing knowledge, feedback and insights gained from codesign activities. As such, the author considers codesign as involvement of resource-constrained people in design activities, while taking into account tasks that are necessary for their involvement and for making use of their feedback and knowledge. In addition to the concepts of cocreation and codesign, some studies have employed the construct participatory development or design, offering related accounts and perspectives. Participatory development or design is commonly interpreted as a process by which resource-constrained people contribute towards design and development activities to influence decisions affecting them, avoiding the priorities of outsiders and enhancing the acceptance and adoption of solutions. (Gonzalez et al. 2017; Giles 2001).

Some studies have offered perspectives on involvement of resource-constrained people in design activities with references to specific design sectors. For instance, Alova and Burgess (2017) refer to housing sector and Hooli et al. (2016) refer to platforms known as ‘Living Labs’ which support innovation activities through interaction of various stakeholders.

Overall, it seems that there is a great diversity in using terminology and offering perspectives on the involvement of resource-constrained people in design activities. Whilst cocreation refers to involvement of resource-constrained

individuals and a wide range of partners such as NGOs, companies and local governments in the design and development of solutions, codesign and participatory design appear to focus on the involvement of resource-constrained individuals and communities. As such, all these three concepts—cocreation, codesign and participatory design—consider involvement of resource-constrained people in design and development activities. These concepts typically consider the collaborative, joint process of generating and distributing value in the form of some solutions; thus, highlighting collaborative aspects of the process and related outcomes. Whilst there is a large overlap between such perspectives, one study offers a novel perspective about cocreation. This study focuses on cocreation as generating value through interaction between resource-constrained people. Future research ought to gain deeper understanding of how resource-constrained people cocreate value through various interactions within their own community. This understanding can be useful for practitioners such as companies and NGOs in effectively codesigning solutions with them. Furthermore, offering clear definitions of codesign in this field will not only support the community in gaining insights into related perspectives of researchers, but will also help in developing suitable methods and tools to support practitioners in codesigning with resource-constrained people.

3.2 Theoretical perspectives

Some studies have developed models and frameworks of involving resource-constrained people in design activities. Development of such models and frameworks is not just important in organising and structuring knowledge in this field, but can also usefully support the development of appropriate ways to effectively involve resource-constrained communities in designing solutions (Jagtap 2019a). They can also assist in planning for further research in this field. Some studies have developed models that emphasise the levels of participation of resource-constrained people in design activities, highlighting the purpose and depth of their involvement (e.g. Puri and Sahay 2003; Hussain 2010; Nahi 2016; Knizkov and Allingham 2019). Other studies present models that take into account activities of involving resource-constrained people in design projects, and thus typically emphasise the aspects of codesign process (e.g. Sun and Im 2015; Jakobsson and Pekkala 2015; Galafassi et al. 2018). Models developed in a further group of studies do not exclusively focus on codesign, but consider codesign as a part of those models (Gangadharan et al. 2011; Williams et al. 2012; Santos et al. 2015; Dias et al. 2015; Angeli and Jaiswal 2016).

Some models, emphasising the resource-constrained people's level of participation in design and development activities, draw on the literature in development research field.

Motivated by Gandhian philosophy of village self-reliance, discussions on participation of resource-constrained people began in the 1970s (Gandhi 1962). In the 1980s and 1990s, participation of resource-constrained individuals and communities became a central topic in development studies, partly due to debates on complementing market deregulation with social and human development of societies and discussions on empowerment of resource-constrained societies (Chambers 1983; Pretty 1995; Mohan and Stokke 2000). Based on such literature, which typically articulates different levels of participation such as information gathering, trust building, efficiency pursuing, and to transformation seeking (e.g. Cooke and Kothari 2001), Nahi (2016) has developed a framework of cocreation in the context of resource-constrained communities.

Nahi's (2016) framework considers the 'depth' dimension of cocreation. This 'depth' dimension includes the following four levels. (1) 'Business-driven' or 'legitimation' level aims at undertaking cocreation activities mainly for gaining access to social networks in local communities and for building legitimacy. (2) 'Efficiency seeking' level aims at developing solutions by collaborating with local partners and building auxiliary organisations. (3) 'Sustainability seeking' level aims at ensuring environmental and social value. (4) 'Empowerment seeking' level aims at empowering resource-constrained individuals and communities. Interestingly, the framework also includes the 'width' dimension of cocreation. The width dimension considers the diversity of participants involved in cocreation. Just as Nahi's (2016) framework includes depth dimension of cocreation, Hussain's (2010) codesign model includes the following three levels of user participation: (1) 'included', (2) 'consulted', and (3) 'empowered'. Similarly, Puri and Sahay (2003) conceptualise participation of resource-constrained people as a spectrum covering four levels: (1) 'no participation', (2) 'institution-focused participation', (3) 'user-focused participation', and (4) 'participatory agenda' defined and implemented by the community.

Whilst the above models take into account levels of participation of resource-constrained people, some models emphasise the aspects of codesign process. For example, Galafassi et al. (2018) have developed a process model of cocreation. Using the metaphor of weaving, they conceptualise the knowledge cocreation process in a participatory workshop in the following three iterative steps. (1) Unravelling—in this step, the workshop participants share different types of knowledge. (2) Meshing—in this step, participants generate novel ideas and concepts, and they connect insights with one another. (3) Raveling—in this step, knowledge cocreation proceeds towards shaping new narratives to explore better ways of developing solutions. A few other studies have developed sector-specific models of cocreation process. Sun and Im (2015), for instance,

developed a cocreation framework specifically for micro-finance sector. In a similar fashion, Jakobsson and Pekkala (2015) have developed a design framework in energy sector, specifically targeting the early phases of designing ‘Decentralized Renewable Energy Systems’ (DRES). Although the framework does not exclusively focus on cocreation, it includes cocreation activities in every step of the process. As such, the framework can be interpreted as a broader level model of cocreation process for DRES.

A further group of studies has developed models and frameworks that do not exclusively focus on codesign, but consider codesign or cocreation with resource-constrained people as a part of those models and frameworks. Angeli and Jaiswal (2016), for instance, develop a framework of developing healthcare business models for low-income markets in developing countries. Involvement of resource-constrained people in the process of developing such business models is an integral part of the framework. Cocreation with resource-constrained people is also a part of: (1) Williams et al.’s (2012) ‘Value Flame at the Base of the Pyramid’ model, (2) Letaifa and Reynoso’s (2015) ecosystem framework, (3) Jagtap’s (2021a, b) ‘Frugal-IDEM’ model aimed at designing integrated frugal innovations in resource-constrained societies, (4) Gangadharan et al.’s (2011) service design methodology, (5) Dias et al.’s (2015)

‘compassionate engineering’ process model, and (6) Santos et al.’s (2015) ‘Integrative Justice Model’.

In addition to the above models and frameworks, some studies offer frameworks that represent types of stakeholders involved in cocreation of solutions with resource-constrained people. For example, Rosca and Bendul (2016) develop a framework showing a diversity of actors involved in cocreation such as resource-constrained people, cooperatives, local or international NGOs, religious organisations, and governments, etc. Likewise, Jagtap and Larsson (2019) develop a framework of stakeholder input to cocreate integrated solutions, consisting of products, services, training plans, awareness programs, business models, etc. In a similar fashion, Dwivedi (2015) reports a framework representing a broad range of stakeholders involved in developing interventions in the case of healthcare sector in India.

Overall, the findings suggest that there are following types of models and frameworks representing some aspects of codesigning with resource-constrained people (see Fig. 2).

- The first group of models focuses on levels of participation of resource-constrained people in the activities of designing and developing solutions (Fig. 2a). Although these models use a variety of terms to represent these participation-levels, they typically portray a range of levels, with the lowest level aiming at gaining access

Fig. 2 Different types of models and frameworks of codesign with resource-constrained people

to social networks in local communities and the highest level aiming at empowering these communities.

- The second category of models emphasises the aspects of codesign process, providing a detailed or a broader-level views of the process of codesigning with resource-constrained people (Fig. 2b).
- The third group of models does not entirely focus on codesign, but considers involvement of resource-constrained people in design activities as a part of those models (Fig. 2c).
- The fourth group of models represents different types of partners and their skills and capabilities in cocreating solutions with resource-constrained communities (Fig. 2d).

The review findings about these models and frameworks can support codesign practice in this field. For example, some models articulate various levels of participation of resource-constrained people in design activities, while presenting characteristics of these levels. As such, these levels of participation and their characteristics can support practitioners in understanding at what level they are involving resource-constrained people in design activities. Codesign practice in this field ought to aim at the highest level of participation, i.e. empowering resource-constrained people. Whilst the literature reports various types of models and frameworks, there is lack of models that integrate these models or their aspects. Further implications of these findings are discussed in Sect. 4, while suggesting areas for future research.

3.3 Sources

Some studies have described codesign cases together with their sources, i.e. initiators of those codesign cases or sessions. In revealing the sources of codesign cases, a broad range of studies exists.

Some studies report researchers as sources of codesign cases, reporting their various roles as initiating sources. A few studies report researchers as sources of codesign cases, with their role as participants in codesign activities with resource-constrained people. Dayaratne (2016), for instance, describes a participatory project aimed at designing an affordable settlement for people in a tea estate. As an architect/designer, the researcher conducted participatory activities with the people in the tea estate. In a similar fashion, Tomico et al. (2012) report on a codesign case, with a designer from an academic institute as a source of the case. Likewise, Shroff and Kam's (2011) study reports on codesign sessions with staff of an NGO and low-income women in developing countries. As an initiating source of those codesign cases, the researchers participated in the codesign activities. In addition, accounts of participatory

action research and participatory design, with researchers as an initiating source, are reported in a few other studies (Wood 2016; Dias et al. 2015).

A few studies report on participatory sessions that were facilitated by researchers, although the researchers did not participate in the sessions. Galafassi et al. (2018), for example, report on a participatory workshop organised and facilitated by the researchers. Another example of a participatory session facilitated by researchers is a participatory design workshop reported in the study carried out by Martins et al. (2018). The participatory workshop aimed at evaluating the ability of a conceptual design tool called 2MBio to encourage creativity and enhance design quality of fuel energy systems. Likewise, Brubaker et al.'s (2017) participatory workshops were organised and facilitated by the researchers, with the aim of examining the impact of various design activities such as codesign, and user-generated design, on resulting design outcomes.

In addition to the above participatory cases in which researchers either facilitated or participated in the codesign sessions, a few studies report codesign cases where researchers have only examined codesign activities or the outcomes of those activities. In such studies, the sources of codesign cases are not the authors or researchers. For example, a study focussing on the design of a solar product reports that codesign activities were undertaken by a team of students (Diehl and Verschelling 2012). These students used participatory methods in rural Cambodia to gain insights into daily life circumstances and needs of the people. The authors examined the codesign activities and related outcomes.

The studies discussed above typically report on codesign cases initiated by the researchers. On the other hand, some studies deal with cocreation in the case of the Base of the Pyramid (BOP) approach (Berardi et al. 2014; Parikh and Raghavendran 2014). The BOP approach, articulated by C. K. Prahalad, argues that for-profit companies can design and develop products and services to serve resource-constrained people, creating benefits both for companies and resource-constrained populations (Prahalad and Lieberthal 1998; Prahalad and Hart 1999). Following Prahalad's original idea focussing on for-profit companies, the BOP approach has grown considerably, with many studies showing a great diversity in initiatives undertaken not only by companies but also by social enterprises and social entrepreneurs (Kolk et al. 2014; Jagtap 2019a). Whilst companies and social enterprises may initiate a design project, they need to work with local partners such as NGOs and community organisations to undertake various design and development activities including, among other, codesign with resource-constrained people. Some studies refer to such companies and social enterprises as initiators of design projects, and thereby as a source of codesign cases, in collaboration with local partners (e.g. Nahi 2016; Rosca and Bendul 2016; Bharti

et al. 2014; Goyal and Sergi 2015; Dwivedi 2015; Angeli and Jaiswal 2016). These companies can be multinational enterprises, emerging multinational corporations, small and medium enterprises, and local start-ups. Projects, consisting of codesign with resource-constrained people, undertaken by such companies and social enterprises cover a broad range of sectors such as agriculture, energy, healthcare, and fair-trade. (Bharti et al. 2014; Goyal and Sergi 2015; Diochon and Ghore 2016; Brugmann and Prahalad 2007).

Overall, there is a great diversity in initiating sources of codesign cases, ranging from researchers, multinational enterprises, local start-ups, to social enterprises. When researchers initiate a codesign session, they might engage in codesign sessions as: (1) observers of codesign sessions, (2) as facilitators, and (3) as participants in codesign sessions. However, many studies have not mentioned the initiating sources of codesign cases. In addition, there is lack of studies systematically comparing various characteristics of these sources, and their impact on codesign activities and outcomes of those activities. An exception is Wood and Mattson's (2009) study aimed at investigating the use of design ethnography in a broad range of conditions in the developing world. The knowledge about the impact of various types of sources on codesign outcomes can potentially support codesign practice in this field, for example, by employing appropriate sources. Additional implications of review findings about initiating sources are discussed further in Sect. 4, while suggesting areas for future research.

3.4 Inputs

The literature describes a diversity of inputs in codesigning with resource-constrained individuals and communities, ranging from codesign methods, strengths of resource-constrained communities, to organisational resources. One of the significant inputs in codesign activities is in the form of codesign methods. Codesign aids and support tools assist the involvement of resource-constrained people in design and development activities, facilitate communication and information sharing between them and designers, help local people in understanding and identifying various issues, and stimulate them to generate and evaluate concepts and prototypes to address the issues (Jagtap 2021a, b). Such inputs reduce power imbalance between designers and resource-constrained people and enhance shared understanding between them. Just as there is a broad range of design and development activities supported by codesign methods, there is a diverse range of such methods used in practice (e.g. Jakobsson and Pekkala 2015; Dayaratne 2016; Ambole et al. 2016; Galafassi et al. 2018; Magalhães and Moura 2020). These methods and other forms of inputs are elaborated in the following list.

- **Pictographic methods:** Codesign methods using pictographic media of communication support design teams to convey complex problems and concepts, allowing resource-constrained people to gain insights into problems and potential solutions and share their views with the designers (Jagtap 2020; Galafassi et al. 2018). Such ways of communication typically use pictures, drawings, and sketches. The pictographic ways of communications are suitable in resource-limited societies where people can be illiterate or semiliterate, and where innumeracy rates can be high since they encounter numerous problems in completing primary and secondary education (Pralhad 2004; Jagtap 2019b).
- **Narrative methods:** Communicating using narrative ways, while employing concrete examples, stories and explanation, rather than abstract discussions, are also effective to involve resource-constrained people in design activities and to create common understanding between various participants (Galafassi et al. 2018; Jagtap 2020).
- **Prototyping and generative tools:** A few studies report several types of codesign methods such as prototyping, role-play, use-scenarios, and generative tools such as design games to involve resource-constrained people in design activities (e.g. Goyal and Sergi 2015; Dayaratne 2016; Galafassi et al. 2018; Jakobsson and Pekkala 2015; Arrivillaga et al. 2020).
- **Social assets:** In addition to codesign methods, social assets of resource-constrained communities serve as important inputs in codesign activities (Jagtap 2020). Resource-constrained individuals typically support each other in many different activities, and depend on their social networks to gain information and to accomplish collective activities (Viswanathan 2010; Nakata and Weidner 2012a, b). The inputs, in the form of such social assets, help to enhance awareness in resource-constrained communities about new projects and to facilitate their involvement in design activities.
- **Organisational resources:** Codesigning with resource-constrained people requires organisations (e.g. companies, and NGOs.) to allocate financial and human resources to accomplish various codesign activities (e.g. Jagtap 2020). For example, there is a need of an actor in the organisation for leading and managing codesign activities. Social embeddedness in resource-constrained communities and devoting time to engage with resource-constrained individuals, for example, by participating in local events and festivals (e.g. Goyal and Sergi 2015), also serve as effective inputs in initiating and maintaining codesign activities.
- **Adaptation of methods:** In devising or selecting codesign methods, it is important to consider diversity across resource-constrained societies. This diversity can be in their unmet or underserved needs, various problems they

face, and their capabilities (Prahalad 2004). Whilst general characteristics of codesign methods have an influence on involvement of resource-constrained people in design projects, adapting methods to the specificities of a particular project or using suitable methods to address requirements and conditions of a specific context is essential to engage with resource-constrained people (Jagtap 2021a, b; Dayaratne 2016; Arrivillaga et al. 2020). For example, Dayaratne (2016) elaborates on the use of sorting and location tasks as methods in the design of a low-cost housing. Likewise, Arrivillaga et al. (2020) report use of various codesign methods adapted to the specificities of a healthcare project.

Overall, the review findings suggest that a broad range of inputs can be used in the process of codesigning with resource-constrained people. These inputs can be in the form of codesign methods, strengths and assets of resource-constrained communities, and organisational resources. However, there is lack of studies that systematically compare different types of inputs (e.g. codesign methods) to fulfil some particular objectives in a given context of resource-constrained community. As a consequence, it is not clear which inputs are more or less effective in codesigning with resource-constrained people or in accomplishing some specific activities in the codesign process. Furthermore, the review findings regarding various inputs have implications for codesign practice in this field. The findings reveal many different codesign methods and other forms of inputs (e.g. pictographic methods, narrative methods, social assets, and organisational resources.) that can support codesign activities in this field. The findings also suggest that practitioners ought to adapt codesign methods to the context of a resource-constrained community and specificities of the project. Whilst practitioners may lack resources for using methods such as prototypes, generative tools, and pictographic media, they can use social assets of a community as these assets generally exist in resource-limited societies. It is important that practitioners provide compensation to resource-constrained people when they use such social assets as well as for the time and effort these people invest in codesign activities. The review findings also offer details about codesign methods. For example, regarding narrative methods, practitioners can use the finding that employing concrete examples and explanations is more effective than abstract discussions.

3.5 Success factors

Many studies have revealed a wide range of factors positively affecting interest and involvement of resource-constrained people in codesign processes, while supporting

them in contributing towards design activities. These success factors are elaborated in the following list.

- **Trusting relationships:** Trusting relationships with resource-constrained communities play a crucial role in effective cocreation and codesign (Bharti et al. 2014; Jagtap 2020). When resource-constrained people trust designers and their organisations, they participate in codesign activities without hesitation and willingly share information (Jagtap 2020). Trust between partners also supports effective communication in cocreation processes (e.g. Sarmiento et al. 2020; Letaifa and Reynoso 2015). Building trusting relationships with resource-constrained communities requires transparency in the organisation's work and conduct (e.g. Brugmann and Prahalad 2007; Bharti et al. 2014). In addition, designers can build trusting relationships with resource-constrained communities by providing them information on objectives of the project, without concealing any crucial information (e.g. Jagtap 2020).
- **Offering feedback:** Offering feedback to resource-constrained people on how their participation in completed projects allowed shaping the design work influences their willingness to participate in future projects (Jagtap 2021a, b). Outcomes of successful projects motivate new participants to participate in ongoing as well as future design projects.
- **Local embeddedness:** Resource-constrained people consider locally embedded organisations as an integral part of their community. As such, local embeddedness supports designers in gaining deep understanding of the community's intense needs (Jagtap 2020), and resource-constrained people effectively participate in cocreation when projects are aimed at addressing such crucial and urgent needs of the community (Zanetell and Knuth 2004; Bharti et al. 2014).
- **Codesign experience:** Experience of codesign in the context of resource-constrained societies supports designers in gaining insights into factors that support or hinder codesign with resource-constrained population, and thereby in using strategies that are effective in involving resource-constrained people in participatory activities (Jagtap 2021a, b). Experience of codesign and cocreation activities also motivates resource-constrained people in participating in such activities (Bharti et al. 2014).
- **Offering incentives:** Offering incentives to resource-constrained people has a beneficial effect on their interest in participatory activities. An empirical study suggests that projects aimed at addressing critical and urgent needs of resource-constrained communities act as genuine incentives (Jagtap 2020). In addition, mon-

etary incentives motivate people to participate in projects (Pourhosseini and Korrapati 2009; Bharti et al. 2014).

- **Training programs:** The literature reports that training influences people's interest to participate and engage in cocreation activities (e.g. Kemeny et al. 2003; Bharti et al. 2014). Training programs, aimed at addressing resource-constrained people's deficiency about design activities and tailored to the specificities of their communities and local conditions, are beneficial to support and enhance their participation. Training relevant staff in the organisation also assists in effectively engaging with resource-constrained people in design activities (Jagtap 2021a, b).
- **Moving with the community:** Resource-constrained individuals have several duties with greater significance than participatory activities (Jagtap 2020; Wood 2016). As such, taking a longer-term perspective, patience, and ways to move at the pace of resource-constrained communities favourably influence codesign activities.
- **Gender-related norms:** An empirical study indicates that when participatory activities are conducted by female designers, women from resource-constrained communities may willingly participate and share their opinions and views (Jagtap 2021a, b). This suggests that female-designer-led participatory activities positively influence involvement of women from resource-constrained communities. Furthermore, the rule of law that supports women's rights can encourage women to challenge gender-based stereotypes and hierarchies (Cheston and Kuhn 2002), motivating them to participate in cocreating solutions.
- **Local language:** In addition to the above factors that support codesign with resource-constrained people, learning and using local language and dialects supports cocreation activities (Bharti et al. 2014; Hooli et al. 2016).
- **Building relationships with key people:** In resource-constrained communities, opinion leaders play a crucial role in influencing several decisions. As such, relationships with opinion leaders and lead users supports organisations to enhance participation of local people in value cocreation (Bharti et al. 2014).
- **Adaptive mindset:** Prahalad (2004) argues that a positive mindset towards developing products and service with resource-constrained communities is essential to cocreate value with all the relevant stakeholders. A flexible and adaptive mindset supports designers in codesigning with resource-constrained communities (Hussain et al. 2012). Designers ought to recognise that people living in resource-constrained settings in developing countries are experts in surviving and living in such settings (Murcott 2007).

Overall, a broad range of factors have beneficial impact on activities in the codesign process such as gaining access to resource-constrained people, managing their consistent involvement in design projects, and cocreating with relevant stakeholders. Social embeddedness, using local language, experience of codesign activities, training, offering feedback on completed projects, etc. have beneficial influence on codesign with resource-constrained people. These success factors typically relate to the context of resource-constrained societies, codesign processes, organisational aspects, and aspects of collaboration. These review findings can usefully support designers. Designers can leverage factors that aid codesign activities. For example, designers can use the codesign enabler, namely 'training' in addressing barriers associated with knowledge deprivations of resource-constrained people. Appropriate training programmes, tailored to the specificities of resource-constrained societies, can be used to assist resource-constrained people in developing their knowledge and skills in design, including their capability to contribute towards design activities. Offering incentives to resource-constrained people positively influences their participation in design activities. Since resource-constrained people devote their time and effort in codesign activities and because practitioners use various social assets in local communities, they ought to offer such incentives and provide compensation to resource-constrained people.

3.6 Impeding factors

Several studies have revealed many different factors hindering a variety of tasks in the process of codesigning with resource-constrained people. The literature reports numerous factors having negative or limiting effect on codesign tasks such as gaining access to resource-constrained people, coordinating their consistent involvement, and supporting them in contributing towards design activities. These factors are discussed as follows.

- **Resource limitations:** Resource limitations have problematic effect on various activities in the process of codesigning with resource-constrained population (e.g. Sarmiento et al. 2020; Sushama et al. 2018; Jagtap 2020; Galafassi et al. 2018). Limited resources lead to breaks in projects, with negative consequences on consistency and effectiveness of codesign sessions (Jagtap 2020). Without access to necessary resources, designers are restricted in their ability to codesign with a diversity of resource-constrained individuals, and in using suitable codesign methods and tools (e.g. constraints on employing high-fidelity prototypes).
- **Time constraints:** Just as resource-constraints have negative consequences on codesigning with resource-constrained people, so too are time-constraints. For

example, time constraints limit exploration of concepts and restrict the development of shared understanding from discussions in participatory activities with resource resource-constrained people (Galafassi et al. 2018; Sushama et al. 2018).

- **Lack of organisational support:** Designers can lack support from their organisations in undertaking codesign activities. When there is absence of assurance and interest in participatory activities, and when organisations do not give priority to such activities, designers may undertake codesign only for demonstration (Jagtap 2020). Similarly, participatory activities, undertaken by researchers and academics, can also be limited by bureaucratic procedures in academic institutes as well as by traditional concepts of knowledge (Wood 2016). This can lead researchers to withdraw from codesign activities once they gather data that is enough for fulfilling their academic requirements.
- **Power structures:** Power structures and hierarchies in societies and among participating actors can have negative influence on codesigning with resource-constrained people (Graziano et al. 2019). For example, in some design projects, designers may work simultaneously with both resource-constrained and non-resource-constrained people. In such projects, those who are seen as knowledgeable or as having power and authority can dominate discussions to satisfy their own preferences and interests (Jeffrey et al. 2008; Jagtap 2020; Wood 2016). In addition, differences in power between NGOs and business partners can also limit contribution of NGOs towards the activities of cocreating solutions (Nahi 2018).
- **Knowledge deprivations:** Resource-constrained people may lack access to schooling and also face issues resulting from short-changed education (Chakravarti 2006; Jagtap et al. 2013). As such knowledge deprivations, innumeracy and illiteracy are common issues in resource-constrained communities (e.g. Vachani and Smith 2008; Ahmed et al. 2010; Jagtap 2019b). These issues and unfamiliarity with design tasks have problematic effect on contribution of resource-constrained people towards design and cocreation activities (e.g. Bharti et al. 2014; Nahi 2016; Jagtap 2020; Hooli's et al. 2016).
- **Gendered heterogeneity:** Gendered heterogeneity and associated power relations in resource-constrained communities can hinder codesign tasks (Wood 2016). Several studies have found that codesigning or cocreating with women can be challenging. For example, Shroff and Kam (2011) found that gaining data from women can be challenging, requiring more sensitivity and use of suitable methods. Likewise, Sun and Im's (2015) study highlights limitations experienced by

women in participatory activities, and Wood's (2016) study revealed that gendered power relations may not leave space for women to speak in meetings.

- **Inconsistent participation:** Inconsistent and irregular participation of resource-constrained people in codesign activities is also a barrier (Wood 2016). There are several reasons for their inconsistent participation such as their critical need to find work, sickness, irregular schedule of their work, and family responsibilities (Jagtap 2020; Wood 2016).
- **Remote locations:** Codesigning with resource-constrained population from remote locations can pose difficulties in visiting such locations and managing their involvement in design activities (Jagtap 2020).
- **Misalignment:** Alignment between needs of resource-constrained people and project goals affect codesign and cocreation activities (Bharti et al. 2014; Jagtap 2020). For instance, resource-constrained communities cannot participate effectively in projects, focussing on areas that are not related to their pressing needs.

Taken together, a wide range of factors, associated with the context of resource-constrained societies, codesign processes, organisational issues, and collaboration-related aspects, hinder codesign with resource-constrained people. Resource-constrained people's lack of design knowledge, their limited literacy and numeracy levels, gender-based relationships in their societies, lack of connection between project-aims and their needs, resource and time constraints, and hierarchies in the society hinder activities such as gaining access to their communities, managing their regular involvement in design activities, and making use of their feedback and opinions. The review findings about these codesign barriers, reviewed in the present section, and enablers, reviewed in previous Sect. 3.5, can be useful for design education in this field. Over the past several years, many universities around the world are offering courses in the field of design for resource-constrained societies, while giving opportunities for students to undertake projects and associated fieldwork in developing countries (e.g. Jagtap et al. 2014). As such, the review findings about codesign barriers and enablers can support design education in this field. For example, the findings can support students as well as their academic mentors and supervisors to appropriately plan projects aimed designing solutions with resource-constrained people. For instance, when students plan codesign activities in their projects, they ought to consider various barriers and enablers in their project planning. Likewise, design practitioners can also benefit from codesign barriers and enablers as revealed in the review.

3.7 Outputs

Many studies have identified and analysed outcomes of codesign with resource-constrained people, and these outcomes can manifest in many varied forms. The review findings suggest a broad range of outcomes for designers, resource-constrained people, and other stakeholders. These outcomes are discussed in the following list.

- Insights into the local context:** Studies in several countries, covering many different sectors such as healthcare, agriculture, ICT, energy, and fair-trade have revealed beneficial outcomes of codesign and cocreation for design teams (e.g. Angeli and Jaiswal 2016; Shroff and Kam 2011; Brugmann and Prahalad 2007; Goyal and Sergi 2015; Jagtap and Larsson 2018; De Silva et al. 2020). Codesign helps designers in developing holistic understanding of the context of resource-constrained societies, supporting them in gaining insights into various aspects such as (Dearden and Rizvi 2008; Jagtap 2019a; Jagtap and Larsson 2019): (1) deprivations as well as strengths in communities, (2) how resource-constrained people purchase products or access services, how they perform their entrepreneurial and agricultural activities, how they make and build artefacts, (3) their socio-cultural and economic interactions, their religious beliefs, etc. As such, codesign enhances designer's knowledge and understanding of the community in which the eventually developed solutions will be implemented.
- Requirements formulation and solution development:** Designing with resource-constrained people and other stakeholders plays a key role in formulating a diverse set of technological, socio-cultural, and economic requirements and problems that ought to be addressed. This identification of context-specific requirements permits designers to develop solutions that can satisfy local needs, while making arrangements to integrate the designed solutions in the overall context, taking into account relevant state or national level programs (e.g. Shroff and Kam 2011; Angeli and Jaiswal 2016; Simiyu et al. 2020).
- Co-generation of knowledge:** Codesign with resource-constrained communities and other partners also supports outsiders such as researchers in co-generating scientific knowledge (Ambole et al. 2019)
- Integration of knowledge and resources:** Cocreation between different partners helps to identify and integrate their knowledge, skills and resources, resulting into holistic solutions addressing a diverse range of constraints and deprivations in resource-constrained communities. For example, cocreation allows to synthesise and build on (e.g. Jagtap; Brugmann and Prahalad 2007; Ambole et al. 2019; Carrard et al. 2020): (1) local knowledge and trusted position of NGOs, (2) design skills, technical knowledge, network in non-local markets, and financial resources of 'outsiders' such as companies and professional designers, (3) regulatory power of local governments, including their knowledge about relevant products, services and policies, and (4) informal and tacit knowledge of resource-constrained individuals and communities. Co-creation between communities and a broad range of partners can potentially create greater value for each partner (Dandonoli 2013).
- Social embeddedness:** Codesign with resource-constrained people enhances social embeddedness of outsiders (Goyal and Sergi 2015). Social embeddedness is considered as an input facilitating codesign with resource-constrained people. Codesign in itself can further reinforce social embeddedness of outsiders, thereby creating a virtuous cycle.
- Empowerment:** Several studies have reported beneficial outcomes of codesign and cocreation activities for resource-constrained communities (e.g. Ramesh et al. 2016; De Silva et al. 2020). These studies have been undertaken in several countries, covering sectors such as energy, agriculture, healthcare, fair-trade, craft, slum rehabilitation, and cocreation platforms. (e.g. Sell et al. 2018; Hooli et al. 2016; Wood 2016; Rosca and Bendul 2016; Pathak et al. 2017; Brugmann and Prahalad 2007; Gonzalez et al. 2017; Martins et al. 2018). Codesign can potentially empower resource-constrained people for design projects, giving them a sense of agency for participatory activities and potentially supporting their design capability (Jagtap 2019a). Codesign activities can also contribute towards favourable psychological outcomes for resource-constrained people. For example, resource-constrained people develop a feeling that their views and opinions are valuable in design activities, giving them a sense of project ownership (Gonzalez et al. 2017; Jagtap 2019a).
- Development of skills:** Depending on focus areas of design projects, codesign activities support resource-constrained population in gaining basic education and training in ICT (Hooli et al. 2016), in learning new technological and intrapersonal skills (Wood 2016), in gaining deeper understanding of the issues they face (Mwanzia and Misati 2013), or in improving feasibility of codesigned interventions (Chomat et al. 2019).
- Income generation opportunities:** Cocreation of solutions can also contribute towards developing income generation opportunities in resource-constrained communities, can support entrepreneurial activities of resource-constrained people, and can potentially enhance value of products and services developed in their livelihood-oriented businesses (Brugmann and Prahalad 2007; Hooli et al. 2016; Pathak et al. 2017). A study in agriculture

sector has found that cocreation platforms and associated activities have positive influence on crop yield (Sell et al. 2018).

- **Gender equality:** Participatory activities can also empower female participants. For example, Wood's (2016) study found that participatory activities can assist women in challenging gendered relations in projects, supporting their ability to apply knowledge and skills for their community's advantage.
- **Acceptance and adoption of products:** In addition to the above outcomes, codesign and cocreation has positive effects on acceptance and adoption of designed products and services (Ssozi-Mugarura et al. 2017; Jagtap 2019a). Brubaker et al.'s (2017) experimental study in Zambia found that codesign activities have positive effect on feasibility of concepts and probability of satisfying user-needs. In a similar fashion, Martins et al.'s (2018) study found that participatory design workshops result in more inclusive conceptual solutions, positively influencing important characteristics of conceptual designs. Diehl and Verschelling's (2012) study of solar lights suggests that participatorily designed and tested products can result into appropriate solutions, satisfying crucial needs in the local context. Codesigned products and services also have beneficial effects on the satisfaction of resource-constrained people's needs (Dayaratne 2016; Chew et al. 2013).

Summing up, the review findings suggest a broad range of outcomes of codesign activities for designers, resource-constrained people, and other stakeholders. For designers, the outcomes can be about development of holistic understanding of the target context, gaining insights into strengths and weaknesses of these societies, and generating deeper knowledge about life conditions, needs and aspirations of resource-constrained individuals. Likewise, for resource-constrained people, codesign activities can lead to outcomes such as development of a sense of project ownership and development of their design capability. In addition, depending on the types of design projects, codesign activities can contribute towards their income generation opportunities, and can empower them. Codesign and cocreation also support other stakeholders in integrating their knowledge, skills, and resources to design products and services that can satisfy unmet or underserved needs of resource-constrained people. These findings can support practitioners interested in designing solutions in the context of resource-constrained societies. The findings suggest that practitioners ought to invest their time and resources in codesign activities since these activities have numerous beneficial outcomes, not just for resource-constrained societies, but also for themselves. In addition, codesigning with a broad range of people, including men and women in resource-constrained societies, not

just enhances adoption of designed solutions, but can also contribute towards gender equality.

Whilst the literature describes several outcomes, there is lack of systematic and quantitative analysis of these outcomes. For example, although some studies found that codesigning with resource-constrained people has beneficial effect on their income, they do not report actual increase in their income. Further implications of review findings for research in this field are discussed in Sect. 4. Figure 3 summarises review findings regarding inputs, outputs, success factors, and impeding factors.

4 Discussion and recommendations

In this section, I first discuss limitation of the review, followed by recommendations for further research.

4.1 Limitations

As with any research, there are some limitations to this research study. Whilst I used a comprehensive search approach employing a broad range of search terms and analysed a large number of articles in this field, some pertinent articles may not have been included in the results of literature search. Further research can include additional search terms. In this review, I have not included books from the search results. As such, future research can gain by analysing the content of this type of publications. This review employed two databases, namely, Scopus and Web of Science. Further research can include additional databases (e.g. Google Scholar). This research analysed articles published only in English. The subject of codesign with resource-constrained people is of great relevance in local contexts, particularly in developing countries. As such, relevant papers might exist in local non-English languages. Examining these papers published in non-English languages can further enhance our understanding of codesign with people living in resource-constrained societies. Future research in this field can gain by overcoming the above limitations of this review; for example, by broadening the literature search using additional search agents and including papers published in non-English languages. In view of these limitations together with the scrutiny and synthesis of the literature, the following section present recommendations for future research in this field.

4.2 Suggestions for future research

Some studies have defined or described involvement of resource-constrained people in design projects. However, not offering any definition or description at all about their involvement makes it difficult to understand the related perspectives of the authors, plausibly leaving a broad scope

Fig. 3 Summary of review findings about inputs, outputs, success factors, and impeding factors

for interpretation of their perspectives and hindering the comparative analysis of codesign activities examined in different studies. It is therefore important that future studies offer detailed perspectives or definitions of involvement of resource-constrained people in the design process.

Some models and frameworks of codesign in this field are based on theories in other relevant fields. For example, the models, emphasising ‘depth’ dimension of codesign, are based on the literature in development research field or on

precedent models such as Hart’s (1992) participation ladder and Druin’s (2002) classification of participants’ roles in design. In a similar fashion, future research in this field can develop codesign models by further refinement and integration of existing models of codesign and cocreation with resource-constrained people. For example, future studies can integrate models focussing on ‘depth’ dimension of codesign and models emphasising process of codesign with resource-constrained people. Such models can be based on

empirical research studies analysing codesign processes aimed at empowering resource-constrained people, thus leading to descriptive process models of codesign aimed at empowering people living in resource-constrained societies. Since problems encountered by resource-constrained communities are multifaceted, they are subjects of research in several disciplines (e.g. Bell and Newitt 2010; De Mel et al. 2012; Ravaillon and Chen 2009). As such, codesign research in this field can build on theories in other fields of research such as theories of resource-constrained innovation (Hessels and Terjesen 2010). This can usefully assist in developing holistic models and frameworks of codesign with people living in resource-constrained settings and in creating beneficial impact on codesign in this field.

Some studies have offered details of codesign sessions, clearly reporting initiators of those sessions. In such studies, initiators are typically researchers. However, many studies have not provided detailed information on initiating sources of codesign sessions, making it difficult to identify or interpret the initiators of codesign activities and posing difficulties in gaining understanding of various characteristics of initiators. The knowledge about initiating sources of codesign sessions is important because various types of sources might influence codesign activities in different ways. For instance, sources such as researchers, NGOs, multinational enterprises, local startups, and social enterprises generally differ in their knowledge and capabilities, their local networks, and their intentions behind initiating codesign sessions. For example, codesign sessions initiated by researchers are typically aimed at addressing some academic objectives (Jagtap 2019a). On the other hand, those initiated by NGOs may aim at addressing a local problem. As such, the review findings lead to a call for reporting initiating sources of codesign sessions and for more rigorously describing their characteristics and intentions. Future research efforts may also gain from systematically comparing characteristics of various types of sources, and their impact on codesign activities and resulting outcomes.

The literature reports a great diversity of inputs in codesigning with resource-constrained people. However, what is lacking is controlled and systematic evaluation of different types of inputs and comparison between inputs that are aimed at achieving same goals. Consequences of this lack of systematic evaluation are that practitioners might use inputs that are less effective than others to achieve a specific purpose and researchers might develop inputs, for instance, in the form of new codesign methods, by building them on existing methods that can be less efficient or difficult to use. As such, future research efforts ought to aim at systematically evaluating and comparing inputs such as codesign methods and organisational resources to assess their impact on codesign processes and resulting outcomes. This can be achieved by using quantitative methods such as experimental studies and

closed questionnaires (Frankfort- Nachmias and Nachmias 1996). If conditions permit, future research can also gain by combining both quantitative and qualitative research methods to compare various types of inputs or to assess (un)successful impact of a specific input on codesign outcomes (Tashakkori and Teddlie 1998). Such future studies ought to provide details of resource-constrained communities where the evaluation might be conducted. This can allow to make generalisations or explain differences in findings gleaned from evaluation of specific inputs in similar or different resource-constrained communities. Furthermore, since there is a wide range of inputs, there are numerous interesting opportunities to undertake future research aimed at evaluating these inputs. For example, in addition to the evaluation of codesign methods, future research in this field may aim at evaluating different degrees of codesign capabilities and resources of organisations.

The review findings about factors supporting and hindering codesign allow suggesting actions for future prescriptive research in this field. The findings about these supporting and impeding factors might provide a basis for devising codesign methods and tools in this field. Researchers can develop codesign methods to address specific hindering factors. For example, future research can benefit from developing codesign methods specifically tailored to the needs and conditions of resource-constrained communities living in remote locations because designing with resource-constrained people living in difficult-to-access and remote locations is one of the codesign barriers. In addition to developing codesign methods for addressing specific barriers, future research can also gain from developing toolkits to holistically address many varied codesign barriers. Such toolkits can be built on existing design methods, for example, on IDEO's toolkit called 'The Field Guide to Human-Centered Design' which includes cocreation strategies (IDEO 2021).

Resource-constrained people contribute towards designing products when they participate in codesign activities. As such, future studies ought to investigate issues about intellectual property rights, and how resource-constrained people can be granted patents when their contribution to design activities leads to patentable products. These patents can be considered as a form of incentives or compensation for using efforts and social assets of resource-constrained people.

Whilst the literature reports many varied outcomes of codesign activities, there remain several aspects that ought to be examined. Although such under-examined or not-examined aspects might be considered as a matter of concern, they represent avenues for further research in this field. For example, because there is a lack of quantitative and systematic analysis of codesign outcomes, future research can aim at addressing these gaps, while reporting details of actual design outcomes. Future studies, for instance, need to report actual increase in the income of resource-constrained people, rather than just mentioning that codesign

activities enhanced income without stating actual increase in their income. In a similar fashion, future research can benefit from detailed articulation of other codesign outcomes such as ‘empowerment’ of resource-constrained people, for example, by providing details of resource-constrained people’s views about empowerment or how they interpret other intangible outcomes of codesign. Furthermore, future research can gain from examining long-term impact of codesign activities on resulting outcomes, or comparing outputs of codesign projects with non-codesign projects using large-scale and longitudinal studies (for example, see Rainock et al. 2018 for assessing social impact of products). Finally, I hope that this systematic literature review will motivate and support researchers to investigate the discussed and suggested areas for future research as they are important for practice, research, and education of codesigning solutions for the betterment of millions of people living in resource-constrained societies in developing countries.

Appendix 1 The list of 42 searches.

poverty AND “co-design”	bop AND “co-design”
poverty AND codesign	bop AND codesign
poverty AND “co design”	bop AND “co design”
poverty AND “co-creation”	bop AND “co-creation”
poverty AND “cocreation”	bop AND “cocreation”
poverty AND “co creation”	bop AND “co creation”
poverty AND “participatory design”	bop AND “participatory design”
“base of the pyramid” AND “co-design”	“poor people” AND “co-design”
“base of the pyramid” AND codesign	“poor people” AND codesign
“base of the pyramid” AND “co design”	“poor people” AND “co design”
“base of the pyramid” AND “co-creation”	“poor people” AND “co-creation”
“base of the pyramid” AND “cocreation”	“poor people” AND “cocreation”
“base of the pyramid” AND “co creation”	“poor people” AND “co creation”
“base of the pyramid” AND “participatory design”	“poor people” AND “participatory design”
“bottom of the pyramid” AND “co-design”	poor AND people AND “co-design”
“bottom of the pyramid” AND codesign	poor AND people AND codesign
“bottom of the pyramid” AND “co design”	poor AND people AND “co design”
“bottom of the pyramid” AND “co-creation”	poor AND people AND “co-creation”
“bottom of the pyramid” AND “cocreation”	poor AND people AND “cocreation”

“bottom of the pyramid” AND “co creation”	poor AND people AND “co creation”
“bottom of the pyramid” AND “participatory design”	poor AND people AND “participatory design”

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