

Towards an Architecture of Self-reliance

Developing and Testing a Support Tool for Inhabitants and Practitioners in Mt-Elgon, Kenya

Smits, M.W.M.

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Michiel Smits



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Towards an Architecture of Self-reliance

Developing and Testing
a Support Tool for Inhabitants
and Practitioners
in Mt-Elgon, Kenya

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
by the authority of the Rector Magnificus, prof.dr.ir. T.H.J.J. van der Hagen
chair of the Board for Doctorates
to be defended publicly on
Tuesday, 10 November 2020 at 12:30 o'clock

by

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For Aleksander



Preface

My career as volunteer designer started in 2004 in the harsh reality of a remote village in Kitui province (Kenya). Despite being confronted with the bitter reality of everyday life, I lost my heart to the African continent. Between 2007-2009 I started to initiate, finance, design and construct several smaller building projects in sub-Saharan Africa¹. Over the past ten years I have been involved in the realization of social projects on Mt. Elgon, both as a student and as a professional². Evaluating projects' suitability³ has confronted me with a multitude of discrepancies between the space (dwelling) I designed, and the actual space required by its inhabitants⁴. The project case also, the departure point of this research, realized with Habitat for Humanity Kenya in 2010, proves to be exemplar for analysing the discrepancies which occurred because of my actions as a professional on Mt. Elgon.

For six months I was responsible for the design, management and construction of one hundred houses on Mt. Elgon. Soon after the inhabitants started to live in the realized houses, it became clear that decisions made by me and the financiers⁵ were incompatible with the demands of the inhabitants. In order to deepen my understanding of those demands, I started visiting the communities from which the inhabitants of the project originated. This became the departure point of my master thesis research (Smits, 2011). After several months of investigation, I concluded that I was negatively influencing the wellbeing of the local vulnerable community⁶ I was intending to help.

¹ Sub-Saharan Africa: Refers to all countries that lie south of the Sahara excluding South-Africa.

² Professional: Worthy of or appropriate to a professional within the built environment; educated for a set of factors, competent, skilful or assured, factors meaning: all influences on actors within the built environment.

³ Project Suitability: Extent of which a project suits the requirements (program, knowledge, finance, etc.) of its user(s).

⁴ Inhabitant(s): People living in Sub-Saharan rural housing. Context specific: People living in the direct surrounding of Chepchoina, Mt. Elgon, Kenya.

⁵ Financers: Government and Non-Government organizations in the surroundings of Chepchoina (Mt. Elgon) who resolve social and environmental issues.

⁶ Vulnerable community: A group of people living in challenging circumstances: access to sufficient livelihood (based on international poverty line).

In my master thesis I found that the approach, organization, design, materialization and construction methodology applied by me, decreased the social homogeneity⁷ and self-reliance⁸ of the inhabitants.

Since 2010 I extended my work on Mt. Elgon as a pro-bono architect⁹ realizing projects such as: houses, schools and orphanages. Paradoxically, I was incapable to address the conclusions of my master thesis in the projects I designed and built on Mt. Elgon. Therefore, my goal for this research is to find the necessary tools to sustain inhabitants' self-reliance in relation to their housing on Mt. Elgon, by introducing participatory strategies¹⁰ and tools for the professional to use. Describing a sensitive approach¹¹ with the necessary tools¹² for professionals to articulate housing solutions to sustain the inhabitants' self-reliance in relation to their housing.

7 Homogeneity: The quality or state of being all the same or all of the same kind.

8 Self-reliance: The ability to provide housing on one's own powers, knowledge, materials and construction methodologies.

9 Pro-bono architect: Undertaking processes in the articulation and/or construction of buildings without charge for clients on low income.

10 Participatory strategies: Consensus-building approaches which integrate the inhabitants in the process.

11 Sensitive approach: Project approach which respects the context and includes its inhabitants.

12 Tools: Methods, frameworks and approaches articulated in objects, media, or computer programs, which can be used for a specific (design) goal or task.





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Samenvatting

De titel van deze thesis is 'Naar een Architectuur van Zelfredzaamheid, door middel van het Ontwikkelen en Testen van een Hulpmiddel voor bewoners en professionals op Mt. Elgon, Kenia'.

Dit onderzoeksproject focuste op het niveau van de zelfredzaamheid die lokale bewoners ervaren in hun huisvesting die gerealiseerd is door professionals. Meer specifiek richtte het onderzoek zich op de vraag hoe beslissingen, gemaakt door professionals bijdragen aan het zelfredzaamheidsniveau die inwoners van gemeenschappen in Sub-Sahara Afrika ervaren in hun huisvesting. Een laag zelfredzaamheidsniveau drukt hier het onvermogen uit die bewoners ervaren in het onderhouden, uitbreiden of repliceren van hun huisvesting. Niet alleen had de meerderheid van rurale Sub-Sahara Afrika inwoners onvoldoende financiële middelen, maar ook, en nog belangrijker: onvoldoende gereedschap, kennis en vaardigheden om verbeteringen zelf aan hun woningen te kunnen realiseren.

Dit onderzoeksproject trachtte bewoners in Mt. Elgon, Kenia, te helpen om hun huidige zelfredzaamheidsniveau in relatie tot hun woning te behouden door het integreren van hun huidige capaciteiten (beschikbare financiële middelen, materialen, gereedschap, kennis en kunde) in het ontwerpproces. Veel families in Sub-Sahara Afrika worstelen om zelf hun voorkeurswoning te realiseren omdat zij zelf onvoldoende capaciteiten hebben om zich dit type woning te kunnen veroorloven. Dit komt voornamelijk door de discrepantie tussen bestaande bewonerscapaciteiten en de capaciteiten die zij nodig hebben in het onderhoud van verbeterde woningen. Daar komt bij dat bewoners in deze gebieden in toenemende mate uitgesloten worden in het realisatieproces van hun woning. Vroeger realiseerden bewoners hun woning zelf en waren zij grotendeels afhankelijk van de capaciteiten aanwezig in hun gemeenschap. Gedurende de laatste jaren is dit verschoven naar een toenemende afhankelijkheid van capaciteiten buiten hun gemeenschap (zoals wat betreft middelen als partijen).

Professionals die woningen hebben gerealiseerd in het bestudeerde gebied waren niet in staat om huizen te realiseren op basis van bestaande bewonerscapaciteiten en hebben niet de juiste hulpmiddelen om bewonerscapaciteiten te evalueren en te integreren in woningontwerp. De probleemdefinitie voor dit onderzoeksproject luidt daarom als volgt: professionals zijn op dit moment niet in staat om

zelfredzame woningoplossingen aan te bieden welke voldoen aan de huidige bewonerscapaciteiten en zijn hierdoor niet onderhoudbaar.

Het kernargument van dit promotieonderzoek is dat de belangrijkste bijdrage aan een onderhoudbaar ontwerp het gebruik is van de beschikbare proximale en perifere capaciteiten in het realiseren van woningen. De noodzaak voor dit onderzoek is tweeledig: ten eerste onderzoeken professionals, werkzaam in ontwikkelingslanden onvoldoende het bewonersvermogen om een project te kunnen onderhouden na de realisatie. Ten tweede realiseren de beschikbare hulpmiddelen en handleidingen, ontwikkeld voor professionals werkzaam in ontwikkelingslanden, onvoldoende het vermogen van bewoners om een project te kunnen onderhouden na afronding. Het gevolg van deze beperkingen in de praktijk leidt tot het risico dat bewoners hun huidige woningsituatie niet kunnen verbeteren en in toenemende mate afhankelijk zijn van middelen die zij zichzelf niet kunnen veroorloven, mede doordat zij het onderhoud niet zelf meer kunnen verrichten. Dit is met name van toepassing voor de woningen zoals gepresenteerd in de literatuurstudies, casuïstiek en observaties binnen dit onderzoeksproject.

Voorafgaand aan dit onderzoeksproject hebben onderzoeken en literatuurstudies over de projectrealisatie in ontwikkelingslanden bevestigd dat ontwerp hulpmiddelen geschikt zijn voor het gebruik door professionals in projectrealisatie. De auteur paste eerder gebruikelijke ontwerp hulpmiddelen toe (zoals mappen, typologisch onderzoek, etc.), maar stelde toen onvoldoende de bewonerscapaciteiten vast. Het resultaat van dit promotieonderzoek is tweeledig: ten eerste levert het een hulpmiddel op voor professionals om bewonerscapaciteiten in relatie tot hun woning in kaart te brengen. Ten tweede, een hulpmiddel voor professionals om de geïdentificeerde bewonerscapaciteiten te integreren in het realiseren van passende woningen. Welke stappen worden hieronder vervolgens na elkaar aangehaald.

De Design Research Methodology (DRM) is voor dit onderzoeksproject gebruikt om te onderzoeken hoe bewonerscapaciteiten, geanalyseerd en geïntegreerd in het ontwerpproces, kunnen bijdragen aan het verbeteren van de zelfredzaamheid die bewoners ervaren in het realiseren en onderhouden van hun woning. De DRM is geschikt voor dit onderzoeksproject omdat het onderzoekers in staat stelt het geobserveerde probleem in de praktijk te bevestigen, sleutelfactoren en componenten te identificeren. Daarnaast helpt de DRM om iteratief een hulpmiddel te ontwikkelen en te verbeteren, het testen van dit hulpmiddel in de praktijk, bovenal het meten van de impact en geschiktheid, welke resulteren in een Technologisch Ontwerp. Daarom was een hulpmiddel dat professionals ondersteunt in het evalueren en integreren van bewonerscapaciteiten in het ontwerpen van huizen, ontwikkeld en getest in een praktijksetting. In de eerste onderzoeksfase (Research Clarification)

worden het onderzoeksproject en de casus in de bredere context van duurzame woningbouwrealisatie in ontwikkelingslanden gepositioneerd. Het gepresenteerde literatuuronderzoek en de initieel uitgevoerde onderzoeken op Mt. Elgon beschrijven de geobserveerde problemen in de beroepspraktijk.

Het huishoudonderzoek in de tweede onderzoeksfase (Descriptive Study 1) bevestigt de problemen van Mt. Elgon bewoners in het realiseren van verbeterde woningen gebaseerd op hun beschikbare capaciteiten. De literatuurstudie in deze fase voorziet in een dwarsdoorsnede in beschikbare hulpmiddelen voor het realiseren van woningen in ontwikkelingshulp en toont aan dat er op dit moment geen hulpmiddel bestaat dat bewonerscapaciteiten evalueert en hen integreert in woningontwerp. De uitkomsten van deze fase identificeren de hoofdbestanddelen van de Support Tool en de onderdelen die ontwikkeld diende te worden.

In de derde onderzoeksfase (Prescriptive Study 1) zijn de hoofdbestanddelen van de Support Tool ontwikkeld en samengesteld in de Rural Housing Support Tool. De hulpmiddelen voorzien de gebruiker van een handleiding voor het evalueren van bewonerscapaciteiten, en geeft aan hoe deze geïntegreerd kunnen worden in een woningontwerp. Hier is het vertrekpunt voor het ontwerpproces niet gedefinieerd door de functies, afmetingen of de esthetiek, maar door de beschikbare capaciteiten van de familie en hun gemeenschap. Daarnaast beschrijft Prescriptive Study 1 het ontwerp van het quasi-experiment waarin de Support Tool getest is, waarbij alle benodigde richtlijnen (ethische protocollen, communicatieprotocollen, fysieke infrastructuur, opnames, etc.) en het ontwerp van het evaluatief kader voor het meten van de impact en de geschiktheid van de Support Tool zijn gegeven.

De vierde onderzoeksfase presenteert de uitkomsten van het quasi-experiment uitgevoerd op Mt. Elgon van september 2017 tot en met januari 2018. De uitkomsten zijn gebaseerd op een tweeledig evaluatief kader. Ten eerste werd een dubbele interviewcyclus afgenomen met de betrokken families waarvan de eerste cyclus voor, en de tweede cyclus na het experiment uitgevoerd is. Hier geven de families aan wat hun benodigde capaciteiten zijn voor hun traditionele, de huidige, de gewenste, en de nieuwe woning. Ten tweede reflecteerden de teams (professionals en de studenten) op de bruikbaarheid van de Support Tool. Hier gingen de deelnemers van het experiment nader in op de bruikbaarheid van de individuele hoofdstukken van de Support Tool, en adresseerden zij problemen en maakten suggesties voor mogelijk aanpassingen.

De laatste onderzoeksfase (Descriptive Study 2) beschrijft de impact van dit onderzoeksproject. Gedurende het experiment was er een aantal socioculturele problemen die spanningen veroorzaakten in de bestudeerde gemeenschap.

Spanningen waren er zowel tussen de teams en de families, maar ook tussen de teams en het onderzoeksteam. Dit resulteerde in het verwijderen van één familie en één teamlid uit het experiment. De uitkomsten van het onderzoek tonen aan dat bij het afronden van het experiment geen van de families een afgerond huis had. Ondanks dat de meerderheid van de families aangaven dat zij in staat zijn om de woning zelf af te kunnen ronden, is er tot op de dag van vandaag geen van hun woningen afgerond. Afgezien dat dit onderzoek alle ontwikkelde protocollen en alle ethische, academische en overheidsgoedkeuring had, is het twijfelachtig of de uitkomsten van dit onderzoeksproject ethisch acceptabel zijn. Dit met name doordat de meerderheid van de woningen onafgerond zijn.

Door de impact van de interviews was het mogelijk om de verschillen te bepalen tussen de families die een team met Support Tool hadden versus de controlegroep, de families zonder Support Tool. De families met Support Tool pasten meer natuurlijke materialen toe, waren in staat om de woning af te ronden, te onderhouden en uit te breiden of te repliceren. Daarnaast gaven zij aan de middelen te hebben om dit zelfs te kunnen wanneer hun inkomen afneemt. Wel gaven zij aan dat ze dit niet hadden gekund zonder de hulp van hun team. De controlegroep heeft daarentegen enkel niet-lokale materialen gebruikt en geeft aan niet in staat te zijn om de woning zelf af te ronden, te onderhouden, uit te breiden of te repliceren. Daarnaast hebben zij niet de middelen hiervoor, en neemt de kans hiertoe af wanneer hun inkomen afneemt. Daarnaast gaven zij aan dat ze het team alleen nodig hadden voor het voorzien van financiële middelen en het maken van een ontwerp.

Ondanks de kleine steekproef, de problemen tijdens het experiment, de contradicties in de interviews en alle andere onvoorziene beperkingen, heeft de Support Tool significant bijgedragen aan het realiseren van passende woningen voor de families. De controlegroep laat zien dat zonder Support Tool het team focust op het zo snel mogelijk brengen van hulp aan de familie in nood. Hierbij negeren zij de beschikbare gereedschappen, kennis, kunde en middelen, maar belangrijker nog: ontwierpen zij voor de familie hun gewenste woning waarvoor de benodigde capaciteiten ontbraken. Als gevolg hiervan hielp hun team hen bij het werven van financiële middelen om de woning toch te kunnen realiseren.

De impact van dit onderzoeksproject laat zien dat de teams met de Support Tool enorm worstelden tussen hun onderzoek- en ontwerpverantwoordelijkheden. Zij vonden de Support Tool te uitgebreid en nam deze volgens hen te veel tijd in. Dit zorgde ervoor dat zij veel later aan het ontwerp- en technische proces konden starten dan initieel gedacht. Dit leidde tot frustraties bij de teams en hun families, vooral omdat zij wisten dat dit proces bij de controlegroep veel sneller ging. De teams die de Support Tool gebruikten adviseerden de auteur daarom om

sommige hoofdstukken samen te voegen en het aantal activiteiten te reduceren om effectiever te kunnen werken. Ook gaven zij aan dat het ontwerpen en realiseren op basis van beschikbare bewonerscapaciteiten moeilijk te organiseren was en veel meer tijd innam. Dit resulteerde in beperkte applicatie en feedback van de teams op de Support Tool. Dit vraagt om een opeenvolgend quasi-experiment met aangepaste Support Tool voordat deze gepubliceerd kan worden. Ondanks dat zijn delen van de Support Tool geschikt, en waren de supportteams in staat om informatie te verzamelen over het beschikbare gereedschap, de kennis en kunde en de middelen van hun families. En belangrijker nog, zij waren in staat om deze capaciteiten te integreren in het realiseren van alternatieve woningen en overtuigden zij hun families gedeeltelijk in het adopteren van de door hun aangeboden alternatieve bouwoplossingen.

De primaire einduitkomst van dit onderzoeksproject is het technologisch ontwerp zoals gepresenteerd: The Rural Housing Support Tool en digitale hulpmiddelen. De Support Tool adresseert alle benodigde stappen om beschikbare bewonerscapaciteiten te kunnen evalueren, deze te integreren in woningontwerp en het realiseren van dit ontwerp. De bijgesloten usb-stick bij de Support Tool bevat alle digitale hulpmiddelen met betrekking tot de Support Tool. De secundaire uitkomsten van dit onderzoeksproject zijn alle protocollen, instructies, interviewhandleidingen, ethische procedures, toestemmingsformulieren, datasets en transcripties. Deze uitkomsten worden separaat per hoofdstuk benoemt en zijn terug te vinden in de bijlagen.

Tot slot zou er geconcludeerd kunnen worden dat de uitkomsten van dit onderzoeksproject met gebruikmaking van de DRM, bewijs aanvoert dat met applicatie van het Technologisch Ontwerp en Support Tool het mogelijk is om beschikbare bewonerscapaciteiten te analyseren en te integreren in het woningontwerp. Dit heeft een positieve impact op het zelfredzaamheidsniveau bewoners ervaren in relatie tot hun woning.

Summary

The title of this thesis is “Towards an Architecture of Self-reliance, *Developing and Testing a Support Tool for Inhabitants and Practitioners in Mt-Elgon, Kenya*”.

The focus of this research project is on the level of inhabitants' self-reliance regarding their housing articulated by practitioners. More specifically, the research project focuses on how decisions by practitioners contribute to the decreasing level of self-reliance inhabitants of rural Sub-Saharan communities, experience regarding their housing. Which is expressed in the inhabitant's inability to maintain, extend or replicate their houses. Not only does the majority of the inhabitants lack the funds, but more importantly they lack the tools, knowledge and skills. The overall research intended to improve inhabitant's ability to sustain their housing, by integrating their existing capacities in the design process. Many families in rural Sub-Sahara Africa struggle to realize desired housing by themselves as they currently lack the capacities to afford such housing. This is mainly due to the mismatch between the existing inhabitant capacities and the capacities they require to sustain improved housing. Additionally, inhabitants are increasingly excluded from the realization process of their improved housing. In past housing inhabitants largely build houses by themselves and mainly depended on community capacities, which over the years has shifted to an increasing dependency on external capacities. Practitioners realizing housing in the studied area (Mt. Elgon, Kenya) were unable to articulate housing based on inhabitant capacities and lack the appropriate tools to evaluate and integrate inhabitant capacities in housing design. The problem definition for this research project is therefore formulated as follows: currently practitioners are unable to offer self-reliant housing solutions which meet the inhabitant's existing capacities and consequently are unsustainable.

The core argument of the overall PhD research is that the main contributor to sustainable design is the use of available, proximal and peripheral capacities in articulating the built environment. The need for this research is twofold: Firstly; practitioners working in developing countries insufficiently address the inhabitant's ability to sustain a project after realization. Second, the available support tools and manuals developed for practitioners working in developing countries inadequately address the inhabitant's ability to sustain the project after completion. The result of this unsatisfactory practice is the risk that inhabitants cannot improve their housing situation or increasingly depend on resources they cannot afford. This is especially

true for housing as shown by literature-studies, case-studies and observations presented in this research project. Previous research and literature studies about project realization in developing countries confirmed that design support tools are suitable for practitioners to be used in project realization. The author previously used commonly used design tools (mapping, typological research, etc.), which insufficiently capture inhabitant's capacities. Therefore, the main investigation of this research project leads; firstly; to a tool which enables the identification of inhabitant capacities regarding their housing and second: a tool which helps the practitioner to integrate the identified capacities in articulating suitable housing.

The Design Research Methodology (DRM) is used for this research project to research how inhabitant capacity analysis and their integration into design can improve the inhabitant's self-reliance regarding their housing. DRM is suitable for this research project because it allows researchers to confirm the observed problem in practice, identify key-factors and -components, iteratively improve support design, test the support in practice and most important, measure the impact and suitability of the support, producing a Technological Design as a result. A support tool which helps practitioners to evaluate and incorporate inhabitants' capacities into housing design was developed and tested in a practice setting. In the first research phase (Research Clarification), this research project and its locality are positioned in the wider context of sustainable housing in developing countries. The presented literature review and initial conducted research on Mt. Elgon, describe the observed problems in situ. The household survey presented in the second research phase (Descriptive Study 1) confirms the inability of Mt. Elgon inhabitants to realize improved housing based on their existing capacities. The literature review provides a cross-section of available design tools for development aid housing and proves that support for inhabitant capacity evaluation and housing design does not yet exist. The outcomes identify the key-components of the Support Tool and the parts which need to be developed. In the third research phase (Prescriptive Study 1) the key-components are developed and assembled into the Rural Housing Support Tool. The tools provide the user with a step-by-step manual how to evaluate inhabitant capacities and how to integrate them into the house design. Here, the departure point for the design process is not defined by the functions, size or aesthetics, but by the available capacities of the family and their community. Moreover, does the Prescriptive Study 1-phase address the design of the quasi-experiment in which the support was tested, addressing all the required guidelines (ethical protocols, communication protocols, infrastructure, recording, etc.) and the evaluation framework design for the support impact and suitability. The fourth research phase presents the outcomes of the quasi-experiment conducted on Mt. Elgon from September 2017 till January 2018. The outcomes are based on a twofold evaluation framework: firstly, one interview cycle was conducted with the families before the experiment started and one cycle after the experiment

was completed. Here the inhabitants mainly reflected on required capacities for traditional, current, desired and new housing. Secondly, the practitioners and students reflected on the usability of the Support Tool. Here the participants reflected how useful they found the individual chapters, addressed problems in the support and suggested changes.

The last phase (Descriptive Study 2) describes the impact of this research project. During the experiment there were many sociocultural problems which created tensions in the studied community, between the teams and families, and between the teams and the research team. This concluded in one family and one student to be removed from the experiment. The results show that none of the families had a completed house after the experiment finished. Even though the majority of families stated that they are able to finish the house by themselves, none of them were able to finish their house up to this date. Although this research followed the developed protocols and had all ethical, academic and governmental approval, it is questionable if the outcomes are ethically acceptable. Due to the impact interviews it was possible to determine that the support group families which were supported (received teams with developed support too) versus the control group: applied local natural materials, are able to finish, maintain, extend, or replicate the house by themselves, have the means to do so even if their income diminishes and could not have articulated improved housing without the help of their team. The control group family solely used non-local materials, is not able to finish, maintain, extend, or replicate the house by themselves, do not have the means to do so and only needed their team to provide funds and a design. Considering the small sample size, many problems during the experiment, contradictions in the interviews, and all the unforeseen limitations, the Support Tool had a significant contribution in articulating suitable housing. The control group showed that without the Support Tool the team focusses on bringing help as soon as they can to the family in need. Disregarding the family's available tools, knowledge, skills and resources, more importantly designing desired housing based on capacities which they do not have. Consequently, the team brought in funds to help the family to accomplish their goal.

The impact of this research project also shows that the teams struggled tremendously between the research and the design responsibilities. They found the Support Tool to be too elaborate and consuming too much time. This caused the teams to start the actual design and engineering process much later than originally estimated. Leading to frustration with the teams and their families as they knew that the control group was progressing much faster. The team using the support therefore suggested to combine chapters and reduce the amount of activities to be more effectively. They also found that designing and constructing housing based on available proximal and peripheral capacities is extremely difficult to organize and

time-consuming. Resulting in a limited application and feedback from the support teams on the Support Tool. Which will require a consecutive quasi-experiment with adjusted support before the Support Tool can be published. However, looking at the support suitability, the support teams were able to gather information on all the family's available tools, knowledge, skills and resources. Moreover, using these capacities in articulating alternative housing designs and partially convinced the families to adopt alternative building solutions.

The final result of this research project is the technological design as presented: The Rural Housing Support Tool and its digital tools. The Support Tool addresses all steps necessary to evaluate available proximal and peripheral inhabitant capacities, incorporate these into house design, and realize the design. The usb-stick handed out with the Support Tool contains all the digital tools addressed in the support. The secondary results of this research are all the protocols, instruction sheets, interview guides, ethical procedures, consent forms, datasets, transcriptions. These outcomes are separately addressed per chapter and are all the documents located in the appendices.

Finally, it might be concluded that the outcomes of this research project, using the DRM and a design support, provide evidence that, by the application of the technological design and Support Tool, it is possible to analyse available proximal and peripheral inhabitant capacities and integrate these into house design. This has a positive impact on the level of self-reliance inhabitants experience regarding their housing.



1 Introduction

The introduction consists of six sections, starting with the departure point of this research project, pinpointing the two main topics in which the research is located. The second and third section address these topics, followed by the overall scientific and practical relevance of this research project. The fifth section presents the initial problem definition, aims and objectives of the research. The last section addresses the outline of this thesis, followed by the vocabulary of terms.

1.1 Departure Point

In the wake of poverty¹, overpopulation and rapid urbanization of the global south² there is an increasing demand for affordable housing³ for vulnerable communities. Though many successful affordable housing initiatives have been taken in the global south (Bredenoord, Van Lindert, & Smets, 2014), large numbers find difficulties in handing their projects onto the local communities (Kinsbergen, 2014). These difficulties are also observed on Mt. Elgon in Kenya, where the author was involved in realizing improved housing⁴. The design of the realized houses was made abroad, without community involvement, and largely at odds with the communities' building knowledge⁵, skills and practices. In spite of the good intentions of local aid organizations, the author observed that the offered improved housing solutions do

1 Poverty: Condition where people's basic needs for food, clothing, and shelter are not being met.

2 Global South: Refers broadly to the regions of Latin America, Asia, Africa, and Oceania.

3 Affordable housing: Housing that meets the inhabitants' current means (financial, resources and knowledge).

4 Improved housing: Housing units which physically improve the existing housing situation of its inhabitants.

5 Building knowledge: All knowledge & skills involved in the production of housing.

not correspond with the local traditional housing practices⁶. Here housing solutions increased the inhabitants' reliance on hiring external builders⁷ and purchase building materials from outside their community. Tusting et al. (2019) conducted an extensive study on improved housing in sub-Saharan Africa (between 2000-2015) and found that 23% of both rural and urban areas in sub-Saharan Africa have realized improved housing. However, it remains unclear if these improved housing solutions are affordable and accessible for vulnerable groups (AHIS, 2019; Tusting et al., 2019). Durability is an important factor in measuring improved housing (Tusting et al., 2019). However, durability does not cover the inhabitants' ability to afford the required maintenance to sustain the durability of their house. The gap between what people can afford and what they desire in articulating improved housing has caused problems since its introduction on the continent (Moriarty, 1979). To close this gap, Meir, Roaf, & Roaf (2006) call for the optimization of the performance of the vernacular tradition⁸ in Sub-Saharan Africa. This research closes the gap between introduced improved housing which vulnerable inhabitants can't afford with the vernacular housing they can afford (although this housing requires improvement). This gap is closed by developing a support tool which allows practitioners⁹ working in vulnerable rural communities, and for NGOs¹⁰, to include inhabitants' existing capacities¹¹ in articulating improved housing solutions. This support tool will be developed for and measured on Mt. Elgon. However, due to the similarities in living conditions and vulnerability, the findings of this research benefit other comparable communities on the continent and globally. My hypothesis is that inhabitant capacities are paramount in the level of self-reliance inhabitants have in relation to their housing. This research therefore concerns a user inclusive design support¹², which emphasizes on designing and construction processes in the

⁶ Traditional housing practices: All activities, resources, knowledge, skills and tools used in articulating wattle and daub-based housing on Mt. Elgon.

⁷ External builders: Trained and non-trained engineers from outside Mt. Elgon who conduct building/construction activities on Mt. Elgon.

⁸ Vernacular Tradition: Architecture characterized by the use of local materials, tools, knowledge and skills, usually performed without the supervision of a professional.

⁹ Practitioners: A person engaged and experienced in architecture or engineering which is educated for a set of factors, however has a certain level of competence.

¹⁰ Non-Governmental Organizations (NGOs): Organization which operate independently of any government, typically one whose purpose is to address a social or political issue.

¹¹ Inhabitant capacities: Everything an individual can own finance, resources, tools, skills and knowledge.

¹² User inclusive design support: Design tools that emphasize on including users in design processes.

context of self-reliant sustainable housing development on Mt. Elgon. The following sections will introduce the main two topics of this research in relation to inhabitant capacities: sustainable development¹³ and self-reliance.

1.2 Informal Development

The inefficiency of development aid has been a widely debated topic over the past decades (Bhagwati & Agdish, 2010; Dambisa Moyo, 2010; Dichter, 2003; Easterly, Easterly, & William, 2008; Riddell, 2008). A recent study urges the complete overhaul of how aid programs are envisaged and delivered, calling for “user-driven” development solutions (Flint & Meyer zu Natrup, 2019). Since 2007, for the first time in history, the world’s population is predominantly urban (United Nations, 2014). An average of 50% of urban inhabitants in developing countries live in informal settlements (Collins, 1993). In Africa around 61,7% of the urban dwellers live in informal settlements (UN-Habitat, 2015). Although specific data on informal settlements in rural Sub-Saharan Africa is unavailable the majority of the rural population still lives in informal settlements (UN-Habitat, 2015). Informal settlements provide their inhabitants with basic housing. This often leaves them in challenging living conditions (UN-Habitat, 2013). The sheer scale of improving these conditions is so tremendous that it stresses the importance of studying this phenomenon and therefore is the main departure point for this research. In the past decades, the global development agenda has predominantly focused on solving urban problems on informal settlements in developing countries (Skevington, S, Lotfy, & O’connell, K, 2004; United Nations, 2014). These problems often emphasize on exponential urban growth rate through the increase of informal settlement dwellers and birth rates. However, a large contributor to urban growth in Sub-Saharan Africa is the rural to urban migration, especially in Kenya (IOM, 2015; Oyvat, 2017). A large percentage of both urban and rural inhabitants work in the informal economic sector, constituting on average between 30–50% of the GDP in developing countries (Schneider, 2002). The main source of income for the majority of Kenyan rural inhabitants is through horti- and agricultural activities, which are vital for a sustainable food circulation (F. Ellis, 2005). With a large part of the rural

¹³ Informal development: Development without legislation.

population urbanizing this only further increases the food deficits, which is a global phenomenon (Szabo, 2016). This is one of the reasons why Wohlmuth describes the need for a balance between the urban and rural population (2009).

Informal settlers often live in vulnerable conditions having little or no access to appropriate shelter, water or sanitation (United Nations, 2014). The number of people living in these conditions will only further increase, leaving especially the rural areas in Africa much poorer (Beegle, Christiaensen, Dabalen, & Gaddis, 2016). In urban areas, these problematic conditions (within informal settlements) can be explained by rapid growth, poor governance and lack of affordable housing stock (Lucci, Bhatkal, Khan, & Berliner, 2015). Many governments are hesitant to take charge of the situation, as they believe that provision of better conditions for the poor will attract more people and cause slums¹⁴ to grow even further (Lucci et al., 2015). In rural areas, however, these conditions have a different origin. Here the lack of job opportunities and a widening income gap with urban income levels urges rural inhabitants to urbanize (de Brauw, Mueller, & Lee, 2014). Beside income, housing is an important factor for vulnerable living conditions. In an effort to offer a viable alternative to the rural to urban migration, this research therefore focuses on articulating affordable housing solutions for rural inhabitants in Sub-Saharan countries.

As many authors have illustrated, it is difficult for governments and corporations to build the affordable housing required (Cromley, 2008) especially in developing countries (Bredenoord et al., 2014; Mitlin & Satterthwaite, 2013). This implies that, for the majority of inhabitants living in the Global South, alternative housing solutions will need to be sought. Affordable rural housing alternatives, will lean heavily on self-help and self-building practices (Yeboah, 2005) and require the incorporation of existing inhabitant building capacities, which are deeply rooted in their current housing, also called vernacular building tradition (Marcel Vellinga, 2013).

An important departure point for the vernacular architecture¹⁵ discourse was laid in the 1960s by A. Rapoport, P. Oliver and B. Rudofsky. Where Rapoport (1969) and Oliver (1987) tried to provide a cross-section of vernacular housing around the world, Rudofsky (1964) criticized the discourse for focussing mainly on architects. Since then Oliver has performed the most elaborate overview of vernacular housing

¹⁴ Slums: A squalid and overcrowded urban street or district inhabited by very poor people.

¹⁵ Vernacular Architecture: Building characterized by the use of local materials, tools, knowledge and skills, usually performed without professional supervision.

around the world (P Oliver, 2007; Paul Oliver, 1997; M Vellinga, Oliver, & Bridge, 2007). His definition of vernacular housing from 1997 still is appropriate, "forms of housing that are built to meet specific needs, accommodating values economies and ways of life of the cultures that produce them". In their interaction, inhabitants mediate between all the constituents of collective life, both human and material (Toffin, 1994). Their houses are built with local methods and materials often evolving over centuries, passed down to every new generation. This tends to make the vernacular housing tradition mainly bio-based¹⁶, self-built¹⁷ and constructed with a large sense of communal values (Njoh, Ambe, 2006). Unfortunately, the author observed that the realization of houses developed by NGOs on Mt. Elgon, ignores the vernacular tradition. They not only ignore social and cultural factors, but also the community's ability to build, maintain or replicate the project afterwards. Although vernacular self-built housing has much potential, it also has many problematic aspects. The main reason vernacular housing is still widely used among many rural African communities is that they are simply striving to survive (Nel & Binns, 2000) or lack alternatives. Although the living conditions are challenging (Foruzanmehr & Vellinga, 2011), the vernacular housing does provide an ecological friendliness and appropriateness model (Marcel Vellinga, 2013). Moreover, is this model often self-built, and based on the inhabitants' building capacities (Ward, 2019). Due to the nature and characteristics of both used materials and building methods, maintenance of the house is often needed. Although this is considered by many residents as undesirable, the extent and frequency of maintenance is a process which allows the community to constantly practice and improve their built environment, and as a results makes the housing highly resilient towards change (Nel & Binns, 2000). However, the current perception of Mt. Elgon inhabitants on improved housing, diverges strongly from the desired housing perception. For their improved housing, the inhabitants prefer to hire labour and purchase materials (as the household survey later in the research will show). This improved housing therefore contradicts the vernacular tradition which emphasized on self-built houses, (local) available materials, tools, and labour. As a result, it remains unclear how inhabitants and NGOs can prioritize housing solutions according to this opposing tendency between current (vernacular) and desired housing.

To help communities to improve their general Quality of Life (QoL) inspired by what Robert Chambers (1995) calls 'good change', a more holistic departure point is required. Many propositions have been made how to achieve well-being and

¹⁶ Bio-based: Material intentionally made from substances derived from living (or once-living) organisms.

¹⁷ Self-built: Majority of the building activities have been performed by its inhabitant(s).

improved livelihood through housing (Passerini & Marchettini, 2018; Sanoff, 2008; Thorpe, 2007) but none have such a wide scope and level of detail as the recent Sustainable Development Goals (UN, 2019). Although the SDGs provide clear goals and their potential effect they do not reflect if the actual intervention achieves a balance between the level of sustainability and development for the community it targets. Lélé (1991) proposed a development model for the conditions necessary to support human well-being now and in the future. This model for balanced growth separated the two main categories: sustainability and development. Here the inhabitant's capacities (current and future) both ecological and social are combined in the sustainability of their development (left side of Figure 1.1) and weighed against the actual progress (growth & basic needs) aim of the development (right side of Figure 1.1). In other words: the left side of the model refers to the vernacular housing tradition (traditional objectives and ecological sustainability) where the right side of the model refers to the desired change or development. Realizing a balance between those two main concepts forms an important departure point for this research project.

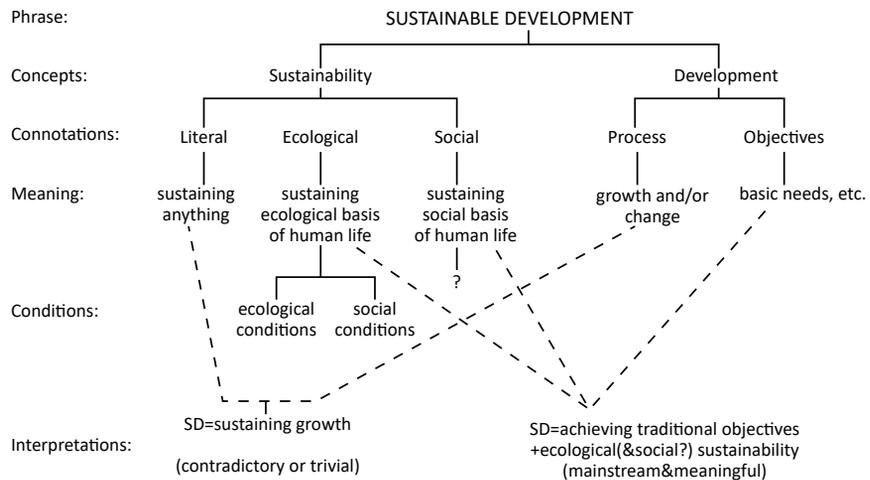


FIG. 1.1 The semantics of sustainable development (Lélé, 1991)

Over the last decades, rural sub-Saharan Africa communities (supported by NGOs) have made rapid improvements to their housing. However, the introduction of industrialized materials and foreign construction methodologies has increased the financial threshold to reach improved housing. Although overall durability and maintenance have improved (Tusting et al., 2019) essential to human security, nutrition and health, and a core objective of the United Nations Sustainable

Development Goals^{1,2}. Globally, the housing need is most acute in Africa, where the population will more than double by 2050. However, existing data on housing quality across Africa are limited primarily to urban areas and are mostly recorded at the national level. Here we quantify changes in housing in sub-Saharan Africa from 2000 to 2015 by combining national survey data within a geostatistical framework. We show a marked transformation of housing in urban and rural sub-Saharan Africa between 2000 and 2015, with the prevalence of improved housing (with improved water and sanitation, sufficient living area and durable construction, applying industrialized materials has created significant external dependency¹⁸ (material, construction and labour). These improvements often are more durable, however are unsustainable¹⁹, non-circular²⁰ and affect the local²¹ housing practise (Amos Rapoport, 2008)Architecture, and Design that summarizes my work on culture-environment relations. Three of its important general points are discussed and some possible misconceptions clarified (e.g. that culture is the only, or most important, variable. What is equally important is that it diminishes the community's self-reliance regarding their housing. For example, although corrugated roofing sheets have a longer lifespan, require less maintenance and are more water resistant, they are expensive, require a carpenter to install, and depend on hired labour for maintenance (see Figure 1.2). Moreover, the roofing sheets dramatically reduce the thermal and acoustic comfort inside the house. The case of Mt. Elgon in Kenya is representative for many rural developing communities on the continent and due to its remote location, provides a relatively less complicated context in which the previous described phenomena can be observed.

¹⁸ External Dependency: Inhabitants increasingly depend on support (finance, resources, tools and skills) from outside their community.

¹⁹ Unsustainable: Inhabitants lack the resources and knowledge to sustain/maintain solution by themselves.

²⁰ Non-circular: All resources that can't regrow and are difficult/impossible to recycle.

²¹ Local: The immediate surrounding in which someone lives.



FIG. 1.2 Rural vernacular, Mt. Elgon, Kenya, 2015 (author: M. Smits)

The household survey later in this study will show that the rural communities on Mt. Elgon struggle to oversee cause and effect in improving the quality of their house. In an effort to improve their housing, the inhabitants of Mt. Elgon use materials that are not locally available, expensive and (more importantly) unfamiliar to them. If these communities are to continue self-reliant housing, they need a solution to improve their housing (extend durability, lower maintenance). A solution which uses mainly local, non-industrialised materials²² and familiar construction methods, without external help (self-reliance).

Complete rural independence in articulating improved housing is an admirable goal, however, the process of alternative improved housing realization is complicated due to a multitude of factors. Firstly, although traditional building methods and materials are highly suitable (capacities, environment, etc.), inhabitants often associate them to poverty and low social status (Sollien, 2011). Secondly, there will always be a dependency on capacities from outside the community (materials, tools, labour, etc.). Thirdly, the rural inhabitant's comprehension of the building practice is insufficient to weigh and prioritize decisions according to their existing capacities.

Vernacular tradition and modern solutions need to complement each other in offering a viable sustainable alternative, a task very suitable for architects and engineers (P Oliver, 2007). Executing this task requires a specific skillset, training, and tools which are rare both in practice as in the education of practitioners. Later chapters in this research will elaborate further on this subject.

²² Non-industrialized Materials: Natural materials that can regrow and be (partially)recycled.

To help articulate support for practitioners intending to develop improved housing that suits the capacities of the inhabitants on Mt. Elgon, the following hypothesis (1) is formulated:

- Inhabitants and practitioners on Mt. Elgon require design support²³ to develop affordable housing solutions that are more attuned to the inhabitants' capacities.

1.3 Self-reliance

As the previous section explained the rural vernacular tradition in Sub-Saharan Africa shows great sustainable and circular housing examples. These examples shed a different light on how contemporary environmental issues might be dealt with. Although vernacular housing is not desired by the Mt.Elgon inhabitants, it does enable them to construct and maintain their housing with local renewable materials, circular building processes and local knowledge (Idoma & Muhammad, 2013). The communities are almost fully able to articulate self-reliant housing²⁴ by providing the necessary materials, tools, knowledge and labour without external support. Nonetheless, this self-reliant model is largely based on local often renewable (natural) materials. Although these materials might be ecologically appropriate, they often lack durability, decrease the living quality, and require more maintenance (Ashby, 2013). In reference to Lélé (Figure 1.1) the materials of the vernacular housing contribute positively to inhabitants' sustainability, although they do slow down their development. This promotes a more detailed and practical assessment is necessary to prioritise development objectives and solutions.

Li & Ng (2014) found that if the building solutions do not align with the inhabitants' capabilities they might weaken their self-reliance (see Figure 1.3). Therefore, they developed the Rural Built Environmental Sustainability Assessment System (RBESAS), which assesses the sustainability (balance) of the development, along two axes: Self-reliance Capability and Development Capability. Here, self-reliance capabilities are all capacities inhabitants are able to successfully deploy to

²³ Design support: To give assistance to a person executing a design task or -process.

²⁴ Self-reliant Housing: The ability to independently provide a house on one's own powers, knowledge, materials and construction methodologies.

articulate housing solutions. The top red arrow (see Figure 1.3) indicates that a fast development can result in a low level of self-reliance. The bottom arrow (see Figure 1.3) indicates that a high level of self-reliance results in an overly slow development. However, how the world population develops is constrained (Meadows, 1974). Finding a balance between how a community decides to develop and to what extent this sustains their self-reliance is essential for the sustainability of their future development.

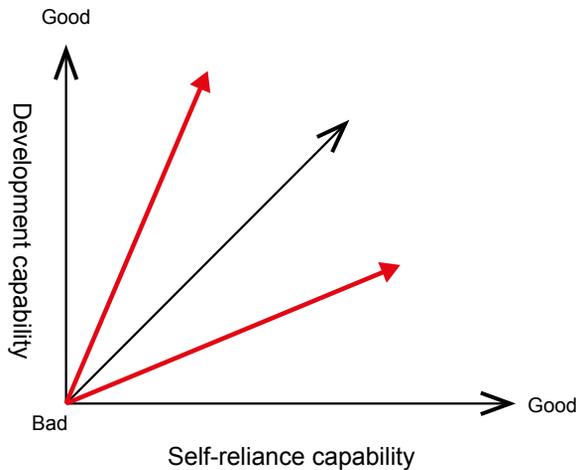


FIG. 1.3 Built environment sustainability of poor rural areas (Li & NG, 2014)

However, the majority of the inhabitants on Mt. Elgon prefer industrialized over natural materials for their housing improvements. This indicates that the vernacular housing tradition on Mt. Elgon slowly comes to an end. These industrialized (non-local) materials and building techniques, lie outside the community's existing capacities. As a result, dependency on non-local materials, labour, and knowledge from outside the community is often needed. This tendency can be traced back to the stakeholders who often deliberately abused this dependency for external partners to benefit (Grudens-Schuck, Allen, Hargrove, & Kilvington, 2003). If the Mt. Elgon community is to remain self-reliant, a balance between their own and external capacities ought to be found (Idoma & Muhammad, 2013). There is, at present, little research on the construction knowledge that inhabitants in places like Mt Elgon hold. This is surprising, since the presented studies illustrate that the existing knowledge inhabitants hold play, a vital role in sustaining self-reliance in their built environment.

Faced with this vacuum this research places itself in the development theory called African renaissance, in which Africans themselves will lead the necessary changes for development (Diop & Modum, 1996). Matunhu (2011), proposes that this theory should be based on existing knowledge frameworks and value systems. It does not reject African systems based on their underdevelopment but uses them as a foundation to articulate new development approaches. Fonchingong & Fonjong (2003) explain that independence is important; however, there will always be a necessity of external support. As inhabitants on Mt. Elgon continue to struggle to improve their housing situation, this indicates that external support and knowledge is required (further investigated later in this research). With their expert knowledge on existing building knowledge and their ability to investigate solutions, building practitioners will need to offer housing solutions without using unsustainable materials (e.g. iron sheet roofs).

How practitioners intervene in this process is crucial to the self-reliance of the inhabitants (Prinet, 2000). Both the model of Lélé as the evaluation system of Lin&NG, lack practical tools to evaluate, weigh and make decisions based on inhabitant capacities. Currently practitioners insufficiently assess the inhabitant capacities on Mt. Elgon and from initial literature review no appropriate support tool was found which does so. Therefore, this research describes a Support Tool for practitioners which enables them to make an inventory of inhabitant capacities and integrate these into the realization process. Improving inhabitants' self-reliance regarding their housing. Later chapters in this research will investigate the role of the practitioner and the need for a Support Tool on Mt. Elgon. These chapters will also investigate existing models²⁵, tools, and frameworks²⁶, in order to describe a suitable²⁷ Support Tool for Mt. Elgon.

²⁵ Models: Are visual representations to clarify frameworks and tools.

²⁶ Frameworks: The essential supporting structure for conducting a (research) project, using various methods and tools.

²⁷ Suitable: Appropriate to practitioners who aim at articulating self-reliant housing in rural communities.

1.4 Scientific & Practical relevance

With foreign financial investment and locally operating NGO's thousands of housing projects have been developed in Sub-Saharan Africa over the past decades (OECD, 1997; World Bank, 2015). However, if the local communities are to maintain, extend or replicate these housing solutions by themselves, there is a need for a more "user-driven" development, which UNDP (2009) also called Capacity Development (CD). However, UNDP describes their capacity development approaches mainly on a governmental and organizational level, which is the case with many of the available tools (Horton, 2003). The majority of available CD-tools mainly focus on policy evaluation (UNDP, 2008). The most elaborate handbook focussing specific on individual capacities was developed by Pact (Dubois, Yakimakho, & Reeves, 2012). This handbook addresses a training program and not an actual framework for project design, realization or evaluation. Although Ubels, Acquaye-Baddoo, & Fowler (2010), provide with an extensive overview of existing case studies and approaches, they lack the presentation of the applicable tools. Furthermore, some of the case studies problematise the role of the expert in the multifaceted context in which they have to work (roles and tasks) and call for the need for more practical applicable manuals and tools. However, they do not offer available tools and how they can be applied in similar contexts. As discussed in the previous section in the initial literature review only one tool and case study were found which evaluated inhabitant capacities on an individual level in the context of realising housing in vulnerable communities (Li & Ng, 2016). Although the previously described support tools were part of an initial search, there is a lack of support tools which can evaluate inhabitants' existing capacities and realize improved housing based on them. Therefore, this research project develops a Support Tool which will help practitioners to evaluate existing inhabitant capacities, integrate these into improved housing solutions, and activate and develop inhabitant capacities through the realization process.



1.5 Problem definition, aims and objectives

1.5.1 Problem Definition

The problem definition is threefold. Firstly, the majority of the communities on Mt. Elgon find difficulties in improving their housing without external help. The inhabitants struggle to maintain, extend, or replicate the housing offered, by external stakeholders' solutions, by themselves. Secondly, practitioners lack training and skills to assess, integrate and develop inhabitants' capacities in realizing improved housing in an aid scenario. Thirdly, there are no existing support tools which help practitioners to evaluate integrate and develop inhabitants' capacities (materials, tools, knowledge and skills) in the realization of improved housing in an aid scenario.

Main problem statement

Currently practitioners are unable to offer self-reliant housing solutions which meet the inhabitant's existing capacities and consequently are unsustainable.

1.5.2 Research aims

This research investigates the disparity between the existing inhabitant capacities and those required for their desired housing at Mt. Elgon. This is an important threshold for inhabitants to articulate improved housing. Their existing building knowledge is insufficient to articulate alternative solutions that do meet their capacities. As previously argued, a crucial factor in habitant's self-reliance regarding their housing. Moreover, external practitioners lack the training and tools to articulate alternative housing solutions that do meet the inhabitant's capacities. For these reasons the main aim of the research is to develop and test a Technological Design: Rural Housing Studio with subsequent Support Tool for practitioners with a practice setting, which helps them to asses inhabitants' capacities, incorporate these capacities into the development of new housing solutions that sustain or improve inhabitants' self-reliance regarding their housing. In order to develop such a Technological Design three aims are formulated.

- The first aim is to investigate how inhabitant capacities can be evaluated by practitioners in situ. This investigation will provide insights in current inhabitant capacities and those related to current and desired housing. Moreover, if practitioners have access to appropriate tools to evaluate inhabitant capacities and integrate them in design housing solutions
- The second aim is that this Rural Housing Studio and subsequent Support Tool should facilitate the identification of family capacities and integrate them into suitable housing design by the involved practitioners. There are two key considerations to determine: firstly, to determine a suitable setting in which the practitioners and family can work together in articulating suitable housing. Secondly, to determine a suitable design support which enables practitioners to gather available inhabitant capacities and integrate them into suitable improved housing.
- The third aim is to test whether the application of the Technological Design sustains or improves the family's level of self-reliance regarding their new housing.
- The fourth aim is to test whether the support tool is suitable for the practitioners in realizing self-reliant housing for rural inhabitants on Mt. Elgon.

1.5.3 **Research Objectives**

The research objectives describe the main steps that will be undertaken in this research project. In the next section these research steps will be described in more detail. The objectives are:

- Describe the methodological framework in which a support tool can be articulated and tested in this research project.
- Investigate the main contributors to inhabitants' self-reliance regarding their housing
- Assess if inhabitants are able to articulate desired housing and what the main thresholds are.
- Evaluate if practitioners are able to articulate self-reliant housing and what their main threshold are.
- Describe the key-components of the design support and develop support tool
 - a How practitioners can intervene in a vulnerable context
 - b How practitioners can evaluate inhabitant capacities
 - c How practitioners can integrate inhabitant capacities into housing design
- Design the experiment in which the support can be tested in practice.

- Articulate the methodological framework to evaluate the support’s suitability and impact.
- Execute experiment and assess the support’s impact and suitability.

1.6 Thesis outline

The thesis is structured as follows:

Chapter 2 offers the theoretical framework for this research, describe the types of research within the research project and how the Support Tool is developed within the Design Research Methodology (DRM) (Blessing & Chakrabarti, 2009). Moreover, explains which DRM cycle was chosen and states per phase the expected deliverables.

Chapter 3 to 6 present the outcomes of this research and elaborate on the results of the various DRM research stages. They present and explain the outcomes of each DRM research phase, starting with the Research Clarification (chapter 3). This chapter will investigate the main contributors to self-reliant housing and the ability of inhabitants of Mt. Elgon to articulate desired housing by themselves.

The Descriptive Study 1 (chapter 4) investigates the factors that hindered success in the case studies and describes the necessary key components of the design support. Together, chapters 3 and 4 articulate the basic input for the intended design support, which is articulated in chapter 5: The Prescriptive Study I.

The Prescriptive Study 1 (chapter 5) starts by describing how both engineering practitioners can approach a vulnerable context. Moreover, it demonstrates how they can evaluate inhabitant capacities where housing is concerned and integrate them into the housing solution. The last section of chapter 5 describes the framework in which the impact²⁸ of the support and its suitability²⁹ can be measured.

²⁸ Impact: to what extent the targeted family can maintain, extend, or replicate the housing solution based on their available capacities.

²⁹ Suitability: to what extent the support tool fits the competences of its user (student or practitioner) in articulating self-reliant housing for rural inhabitants.

In the Descriptive Study 2 phase (chapter 6), the articulated design support is tested in situ. Here, the outcomes of chapter 5 are conceptualised in the Design Support Tool and its key components. The final Technological Design Inclusive Support Tool was tested in situ (Mt. Elgon) with students and practitioners. The formulated evaluation cycle assesses the impact of the tool on the inhabitants' self-reliance, comparing their new housing situation with their former housing situation.

Chapter 7 presents the conclusions, reflection and recommendations. The conclusions are keyed to the goals of the research project, and the hypotheses are either confirmed or denied, referring to the Measurable Success Criteria. The first section reflects on use of the key components in the Definitive Inclusive Support Tool. The second section reflects on the outcomes of the field experiments of the Definitive Inclusive Support Tools. Chapter 7 closes with recommendations for future research.

Chapter 8 provides the appendices.

1.7 Vocabulary of terms

In order for the reader to follow the argumentation, a number of terms that frequently appear or are of the importance to the research project must first be clearly understood. To this end, a vocabulary of terms is compiled (see Table 1.1). It is important to point out that many of the terms must be understood as working definitions for this research project. Many of the mentioned terms might differ in meaning outside this research project. The key terms are presented below in a table alongside their working definitions.

TABLE 1.1 Vocabulary of terms and working definitions.

Affordable housing	Housing that meets the inhabitants' current means (financial, resources and knowledge).
Bio-based	Material intentionally made from substances derived from living (or once-living) organisms.
Building knowledge	All knowledge & skills involved in the production of housing.
Design support	To give assistance to a person executing a design task or -process.
Developing countries	A country with little industrial and economic activity and where people generally has low incomes.
External builders	Trained and non-trained engineers from outside Mt. Elgon who conduct building/ construction activities on Mt. Elgon.
External dependency	Inhabitants increasingly depend on support (finance, resources, tools and skills) from outside their community.
Financers	Government and Non-Government organizations in the surroundings of Chepchoina (Mt. Elgon) who resolve social and environmental issues.
Frameworks	The essential supporting structure for conducting a (research) project, using various methods and tools.
Global South	Refers broadly to the regions of Latin America, Asia, Africa, and Oceania.
Homogeneity	The quality or state of being all the same or all of the same kind.
Impact	To what extend the targeted family can maintain, extend, or replicate the housing solution based on their available capacities.
Improved housing	Housing units which physically improve the existing housing situation of its inhabitants.
Informal development	Development without legislation
Informal settlements	Group of housing built on land that the occupants have no legal claim to or occupy illegally
Inhabitant(s)	People living in Sub-Saharan rural housing. Context specific: People living in the direct surrounding of Chepchoina, Mt. Elgon, Kenya.
Inhabitant capacities	Everything an individual can own finance, resources, tools, skills and knowledge.
Local	The immediate surrounding in which someone lives.
Maintenance	The process of preserving a building through regularly checking and repairing.
Models	Are visual representations to clarify frameworks and tools.
Non-circular	All resources that can't regrow and are difficult/impossible to recycle.
Non-Governmental Organizations (NGOs)	Organization which operate independently of any government, typically one whose purpose is to address a social or political issue.
Non-industrialized materials	Natural materials that can regrow and be (partially)recycled.
Poverty	Condition where people's basic needs for food, clothing, and shelter are not being met.
Participatory strategies	Consensus-building approaches which integrate the inhabitants in the process.
Practitioners	A person engaged and experienced in a profession which is educated for a set of factors, however has a certain level of competence.
Pro-bono architect	Undertaking processes in the articulation and/or construction of buildings without charge for clients on low income.
Professional	Worthy of or appropriate to a professional within the build environment; educated for a set of factors, competent, skilful or assured, factors meaning: all influences on actors within the built environment.
Project suitability	Extend of which a project suits the requirements (program, knowledge, finance, etc.) of its user(s).
Resilient	The ability to recover or sustain a basic livelihood on one's own capacities after a crisis.

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TABLE 1.1 Vocabulary of terms and working definitions.

Affordable housing	Housing that meets the inhabitants' current means (financial, resources and knowledge).
Self-built	Majority of the building activities have been performed by its inhabitant(s).
Self-reliance	The ability to provide housing on one's own powers, knowledge, materials and construction methodologies.
Self-reliant housing	The ability to independently provide a house on one's own powers, knowledge, materials and construction methodologies.
Sensitive approach	Project approach which respects the context and includes its inhabitants.
Slums	A squalid and overcrowded urban street or district inhabited by very poor people.
Sub-Saharan Africa	Refers to all countries that lie south of the Sahara excluding South-Africa.
Suitability	To what extend the support tool fits the competences of its user (student or practitioner) in articulating self-reliant housing for rural inhabitants.
Tools	Methods, frameworks and approaches articulated in objects, media, or computer programs, which can be used for a specific (design) goal or task.
Traditional housing practices	All activities, resources, knowledge, skills and tools used in articulating wattle and daub-based housing on Mt. Elgon.
Unsustainable	Inhabitants lack the resources and knowledge to sustain/maintain solution by themselves.
User inclusive design support	Design tools that emphasize on including users in design processes
Vernacular Architecture	Building characterized by the use of local materials, tools, knowledge and skills, usually performed without professional supervision.
Vernacular tradition	Architecture characterized by the use of local materials, tools, knowledge and skills, usually performed without the supervision of a professional.
Vulnerable community	A group of people living in challenging circumstances: access to sufficient livelihood (based on international poverty line).



2 Research strategy & methodology

The previous chapter introduced this research project and concluded by stating the aim to develop a support tool for self-reliant housing for inhabitants of Mt. Elgon. This largely depends on offering local operating practitioners appropriate support as they show inhabitants of Mt. Elgon how to improve self-reliant housing. Due to the complexity of this research project and its use of mixed methods, an appropriate methodology had to be identified. Therefore, this chapter describes the project's overall methodology. In the first part of the chapter, the type of research and appropriate strategy are outlined. The second part of the chapter explains the concept of design research and reviews the limitations of existing methodologies. The Design Research Methodology (DRM) is pinpointed as the most suitable, and in the third part of this chapter, it is explained in detail. The fourth part gives the research overview, including the identified questions and goals.

2.1 Research Strategy

The problem definition (1.5.1) was based on the observation that current external practitioners on Mt. Elgon are unable to offer self-reliant housing solutions to its inhabitants. This research is therefore an empirical investigation¹ in what constitutes the problem in situ, which is, in this case Mt. Elgon area in rural Kenya (Patten, 2016), within three types of research can generally be described (Weggeman, 2001):

¹ Empirical investigation: Investigation based on the author's priory experiences and observations on Mt. Elgon.

- 1 Qualitative approach that addresses the exploration and description,
- 2 Quantitative research which addresses the explanation and prediction
- 3 Qualitative research that addresses mainly the explanation, prediction and prescription.

As the lack of self-reliant housing is a problem observed in practice it touches upon a multitude of factors and actors, which lie in the realm of architecture, development, urbanism and anthropology. Therefore, this type of the research is difficult to allocate clearly within the borders of one field of expertise as it has no theory or paradigm on its own, or clearly stated and defined methods and practices (Denzin & Lincoln, 2011). As a result, explaining, predicting or prescribing a solution is highly complicated and will need to rely on a complementary use of mixed methods. Below a research proposition is described by three general steps (explanation, prediction and prescription) based on the third type of empirical research by Weggeman (2001).

2.1.1 Explanation

The problem has to be studied and its existence proven in practice (explanation), therefore this research commences by analysing the current- with the desired housing situation of rural inhabitants on Mt. Elgon, Kenya. Here the author investigates the current capacities of the inhabitants, how these enabled them to realize current housing, and which obstacles they experience in realizing desired housing. Moreover, investigating if their current capacities meet the required capacities for desired housing and if they think the inhabitants would be able to bridge this capacity gap² by themselves. This will help compare the inhabitants' level of self-reliance in relation to current and desired housing. Moreover, it will enable the author to determine if there is a possible need for external help³: confirming if the problem exists in practice. The survey methodology is chosen because it allows to compare the motives and opinions of a large group of inhabitants from multiple communities on Mt. Elgon (Fowler, 2013). By targeting different communities in various stages of development (in relation to their housing) a comparative study can be conducted to investigate if a capacity gap exists. Furthermore, this research exploring if the case-studies correlate in that they illustrate a decrease of the level of self-reliance of the inhabitants in relation to their housing. The outcomes of this survey will offer insights in the inhabitants' motives for desired

2 Capacity gap: Disparity between current capacities and the capacities required to realize desired housing.

3 External help: Any form of assistance/capacities a person requires in order to realize housing.

housing and if they can afford them. Which helps exposing the financial constraints inhabitants experience in realizing desired housing, if they need external help in articulating improved housing, and if they prefer to self-build their housing.

Besides analysing the socio-economic background of inhabitants, it is important to analyse how these relate to spatial and cultural aspects. According to Ritchie et al. (2013) case study designs can build up very detailed in-depth understanding of observations made in practice. Therefore, the author will conduct multiple case studies to investigate the level of self-reliance in the various steps of development (neighbourhoods) found on Mt. Elgon. Moreover, these case studies will offer the basis for an in-depth investigation of the role of professionals in realizing housing and their ability to articulate self-reliant housing. Consecutively a literature review will be conducted to investigate firstly, how the capacities of the inhabitant correlate (or not) with the level of self-reliance which inhabitants have regarding their housing. Secondly, the author will address existing tools (approaches, methods and frameworks) that can be used to assess inhabitants' capacities regarding their housing. Both outcomes will be used to describe the key components⁴ for the Support Tool developed for practitioners to articulate improved housing solutions for Mt. Elgon inhabitants. Thus, addressing the factors that hinder success and those factors that have the strongest influence on success (Blessing & Chakrabarti, 2009). The outcomes of the explanation are used to identify the key factors⁵ that in the process of articulating self-reliant housing in the context of Mt. Elgon.

2.1.2 Prediction

To predict which support tools benefit the inhabitants' improved level of self-reliance regarding their housing, a state of the art analysis is chosen (Gile, Dam, Dubslaff, Martinsen, & Schjoldager, 2001). Here, a comparative study of existing support tools is made to gather available support components and describe the key-components of the Support Tool (Blessing & Chakrabarti, 2009). These key-components consist of existing approaches, methods and tools, that potentially increase the level of self-reliance. The outcomes will be used to predict the most successful approaches, methods and tools which will be used to prescribe the Support Tool. Moreover, to identify missing support components.

⁴ Key components: Crucial elements of a support tool to articulate self-reliant housing solutions.

⁵ Key factors: Crucial people, resources and organization for articulating self-reliant housing solutions.

2.1.3 Prescription

The goal of this research project is to develop a support tool for practitioners that intend to provide rural inhabitants with new housing models. The state-of-the-art analysis will identify applicable key-components as well as the missing components of current approaches, methods and tools. In the so-called 'prescription phase' new components are developed to fill the previously identified gaps. These are then combined with the found key components to describe the Support Tool. Next, a framework to test the articulated support will need to be articulated. As the conditions (complexity problem, context, etc.) and the possible impact of the support are specific to the context of Mt. Elgon they don't allow a full experiment setting and therefore will be tested in a quasi-experiment⁶ setting (Bailey, 2008). This quasi-experiment will enable an in-depth analysis of at least two success criteria in the project process. In it different teams of practitioners will use the support on a comparable housing assignment, and their performance will be compared. The Support Tool will be tested in set conditions, generating detailed information on the impact and suitability of the support in one community on Mt. Elgon.

An evaluation framework will be developed which measures the level of self-reliance before (current housing) and after the quasi-experiment (improved housing). The outcomes of the different projects can be compared and generate insights in the suitability of the developed support for sustaining inhabitant's self-reliance regarding their housing. For the experiment convenience sampling⁷ (Creswell, 2013) will be used to select the candidates to test the Support Tool and also in selecting the inhabitants who will receive the team to articulate improved housing. The financial constraints of this research will allow the participation of 4 families (inhabitants) and a maximum of eight participants (practitioners). To measure the impact of the used support tool, the outcomes of the support groups⁸ will have to be compared to that of a control group⁹ (Collins, 1993). Based on a list of application criteria four comparable families (number of members and current type of housing) from one community are sought. To prevent influences between the families, four families will be selected that aren't direct neighbours.

⁶ Quasi-experiment: Experiment setting in which the participants (both inhabitants as practitioners) are not randomly sampled.

⁷ Convenience sampling: Is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher.

⁸ Support groups: Refers to the teams and the families working with the support.

⁹ Control group: Refers to the team and the family working without the support.

To prevent research bias both the composition of the support teams using the Support Tool or not (control group) and appointing the teams to the families, will be randomly sampled¹⁰ (Dattalo, 2010; Thompson, 2012). With participants working simultaneously on different housing (however comparable) projects, the outcomes can be compared with as minor differences as possible (comparable design task for all teams) within the experiment settings and sample. This research is therefore an empirical investigation in the explanation, description and prediction of how practitioners can support inhabitants to sustain their self-reliance regarding their housing. It aims at describing, testing and evaluating the Support Tool and it measures its impact on the inhabitants' level of self-reliance regarding their housing. Additionally, the suitability of the Support Tool will be evaluated by its users (the practitioners). Consequently, this research requires a twofold methodology which firstly identifies necessary components of the support, develops these into appropriate tools and tests this content in practice. Secondly, identifies necessary methods, assemble these into an evaluation framework and test these in practice to measure the impact of the articulated support. The next section will investigate which research methodology is appropriate for this type of investigation.

2.2 Research Methodology

Design research is a rapidly growing research domain and specifically, the role of design research and how it constitutes to articulating solutions in practice (Joost, Bredies, Christensen, Conradi, & Unteidig, 2016). Many scholars investigate the capacity of designers to perform research (Birkhofer, 2011; de Vries, Cross, & Grant, 2013; Rampino, 2012) or explore the implementation of design research in practice (Crouch & Pearce, 2013; Laurel, 2003; Rampino, 2012). Only few researches have studied the practical implications¹¹ of design research within the context of a PhD dissertation (Durdella, 2017). Moreover, current literature insufficiently provides with suitable frameworks that include the explanation, description and prediction of design support as part of an empirical research, in which various methods can be

¹⁰ Randomly sampled: Is a procedure for sampling from a population in which (a) the selection of a sample unit is based on chance and (b) every element of the population has a known, non-zero probability of being selected.

¹¹ Practical implications: Step by step explanation how something can be used in situ.

deployed simultaneously. The frameworks which are available, are often developed for a specific expertise and therefore might not be directly applicable in the field of design support within the built environment.

With architecture engaging in a variety of spatial, social and contextual issues (Awan, Schneider, & Till, 2013) researchers in this field are left with the complexity of making the myriad of individual research outcomes comparable. According to Blessing & Chakrabarti (2009) current design research gives rise to three main issues:

- 1 The lack of overview of existing research
- 2 The lack of use of results in practice
- 3 The lack of scientific rigour

In their Design Research Methodology (DRM) Blessing and Chakrabarti (2009) developed a framework specifically for the design discipline. The formulated process supports researchers in developing design research step by step. This framework aims specifically at validating design methodology research by defining goals clearly, describing success criteria, developing strategies, measuring results in practice and proving success criteria in clear steps.

The proposed design research methodology depicts a layout that permits the use of a combination of mixed research methodologies in one framework. This is mainly achieved by: how the problem addressed in situ can be evaluated (Mt. Elgon, Kenya), how the solution (success) can be articulated by developing a functioning support tool, and how the impact of the support can be evaluated. The main goal of the DRM is to describe a suitable Support Tool or in case of (partial) failure, providing clear insights to possibly continue research in the consecutive DRM-stages or research continued by others. The next section will elaborate more on the DRM and which type of research will be performed based on the methodology.

2.3 DRM framework in detail

Based on the previous sections the explanation, prediction and prescription are positioned in the DRM framework within this research project. Figure 2.1 is a graphic representation of the general DRM-framework, indicating the basic means per stage, the general research stages and the main outcomes.

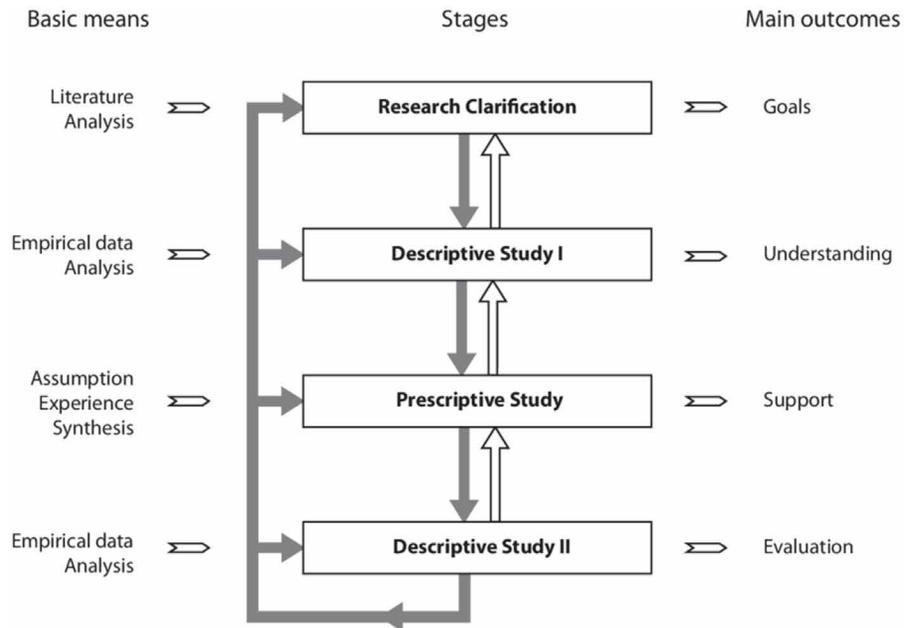


FIG. 2.1 DRM Framework (Blessing & Chakrabarti, 2009)

Blessing & Chakrabarti differentiate seven levels of research performable within the DRM framework (Figure 2.2). Every research differs in available time, literature, funds, etc. Although the research engages on a location with a vast complexity of environment, culture, infrastructure and organization it nevertheless aims at achieving the highest possible suitability.

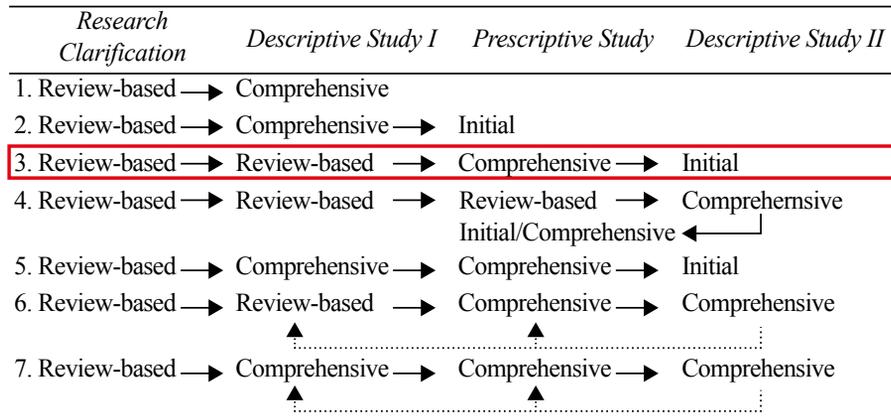


FIG. 2.2 Research Clarification source (Blessing & Chakrabarti, 2009)

Considering the research design mentioned earlier, available time and funds, the third level is chosen. This means that the impact of the tested support will be evaluated and the changes to improve the support will be listed. Therefore, this research will not use the outcomes of the quasi-experiment and the support evaluation to articulate an improved support. This research will end by stating the recommendations, which can be used in a consecutive research to articulate an improved design of both support and its evaluation framework. The following section will briefly introduce the DRM-Stages, position the previously described research strategy and list the outcomes.

2.3.1 Research Clarification (RC)

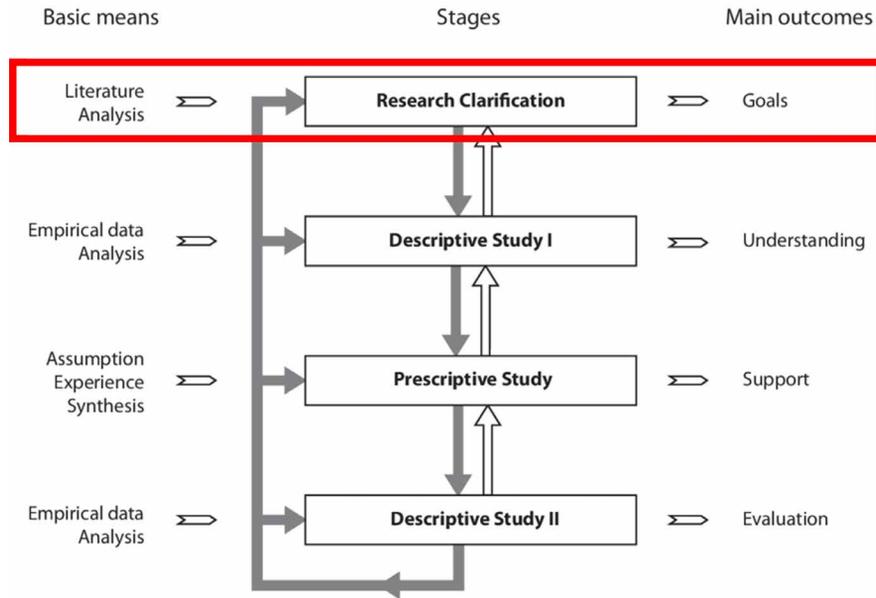


FIG. 2.3 DRM Framework (Blessing & Chakrabarti, 2009)

The Research Clarification (RC) stage (see Figure 2.3) firstly identifies the goals that the research is expected to realise, the focus of the research project, the main research problems, questions and hypotheses. The relevant disciplines and areas to be reviewed and the area(s) in which the contribution is expected. Secondly, to develop initial reference- and impact model which capture an initial picture of the existing and of the desired situation. Figure 2.4, show examples of such models.

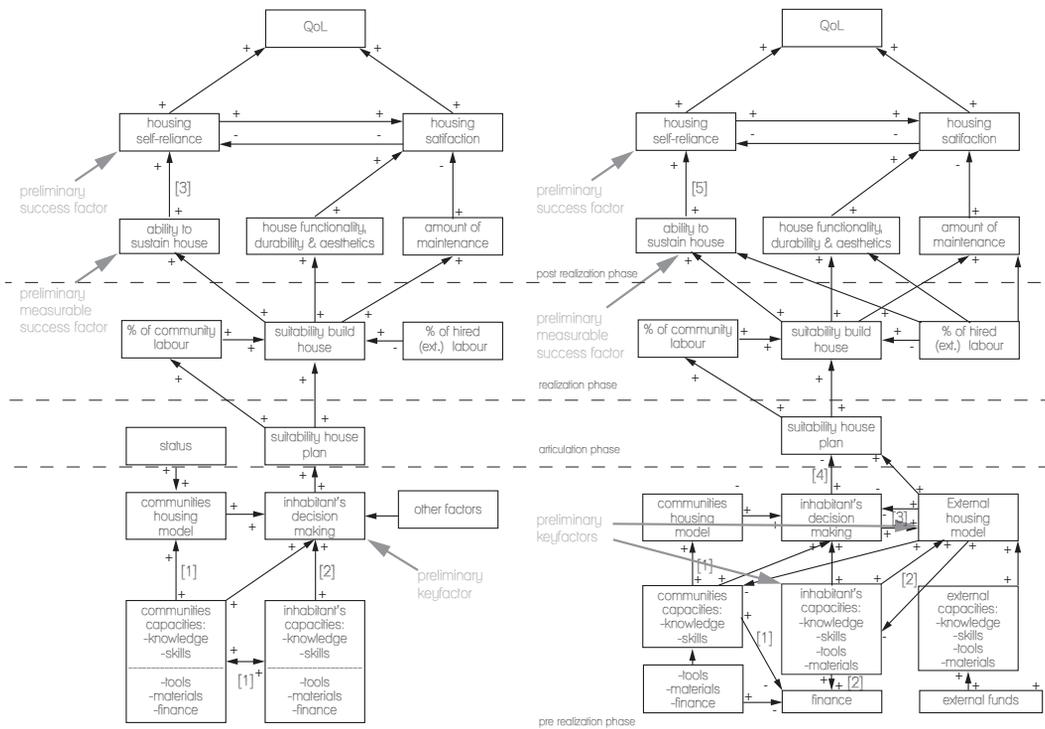


FIG. 2.4 Examples of: Past (left) & Current (right) reference model

Thirdly, the RC-stage identifies a preliminary set of success criteria and measurable success criteria for evaluating the research outcomes (Figure 2.5). Fourthly, the RC-stage pinpoints the factors that hinder success, which will also help to focus on addressing them in developing a support, which has the strongest influence on success. The conclusions of the RC-stage provide a focus for evaluating the effects of the developed support against the goals of the project (Blessing & Chakrabarti, 2009).

The first part of the RC-Phase gives a detailed description of the case (Mt. Elgon) and its relevance to comparable communities in Sub-Saharan Africa. The second part discusses the inhabitants' ability to articulate self-reliant housing and in the third part, this ability is compared between various communities on Mt. Elgon. This section concludes by explaining the importance of self-building practise as a contributor to self-reliant housing. The fourth part describes the status of inhabitant capacities as the main contributor. The fifth part concludes the chapter by answering the first two research questions.

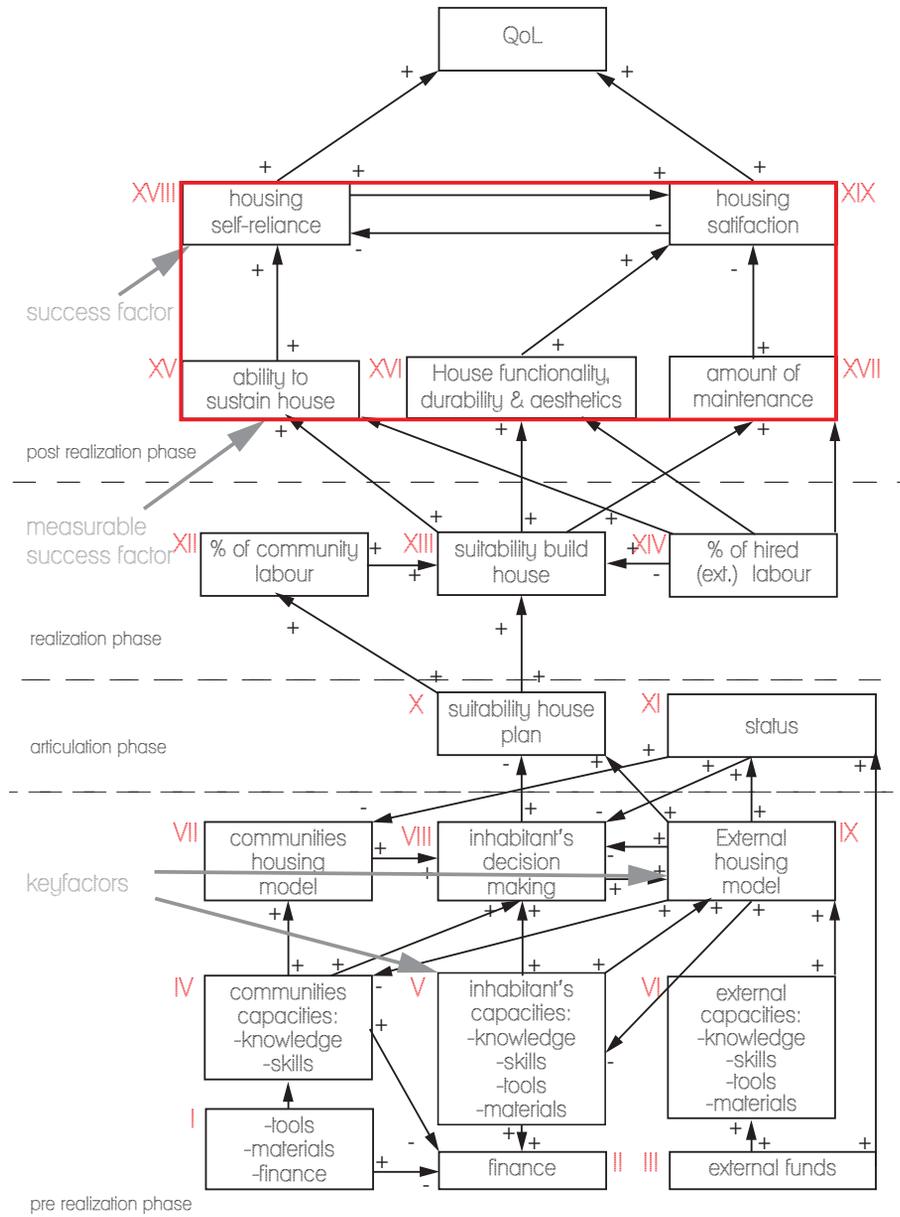


FIG. 2.5 Example of Impact model (desired outcome)

The deliverables of the RC stage are (Blessing & Chakrabarti, 2009):

- Current understanding and expectations
- Initial Reference Model/ Initial Impact Model/ Preliminary Criteria.
- Research focus and goals
- Research problems, main research questions and hypotheses
- Relevant areas to be consulted
- Approach (type of research, main stages and methods)
- Expected (area of) contribution and deliverables
- Time schedule

2.3.2 Descriptive Study (DS-1)

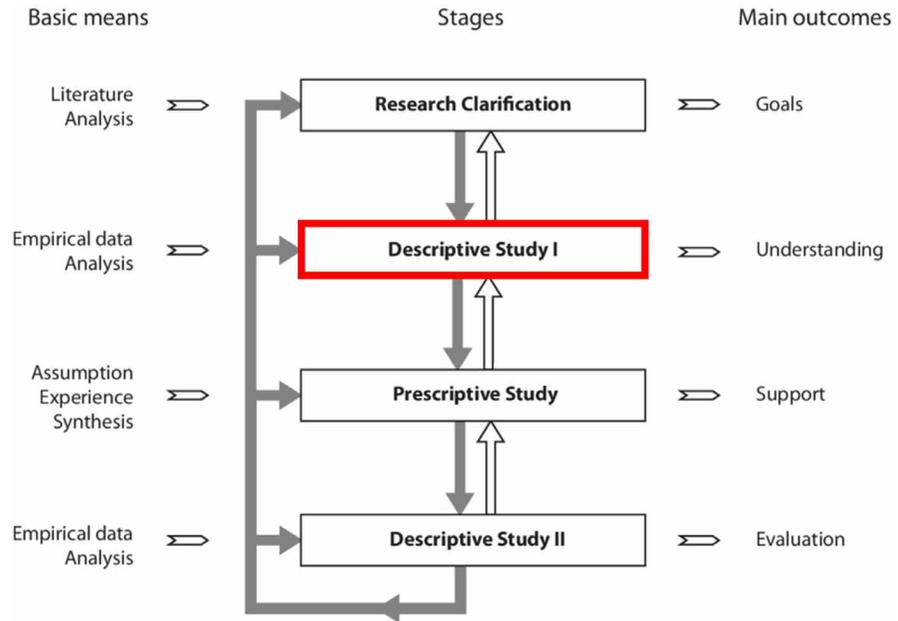


FIG. 2.6 DRM Framework (Blessing & Chakrabarti, 2009)

The main objective of the DS1-Phase (see Figure 2.6) is to enhance understanding of the current situation and the identified problem(s). The observed problem occurs partially due to the inhabitants' inability to provide with improved housing independently and partially due to the external help. This cause a decrease in self-reliance, consequently the problem will be analysed from both perspectives. Through a variety of case studies, the RC-phase shows that similar problems occur in both rural and urban areas. However, to confirm the inhabitants' inability to articulate improved housing, a more thorough investigation on Mt. Elgon is required. Therefore, the DS1-phase evaluates the housing conditions¹² through a household survey of two hundred households in four different communities on Mt. Elgon. The outcomes are used to compare the current and desired housing situation for each community, evaluating their overall housing capacities. This phase concludes by analysing the inhabitants' capacity gaps and the support criteria required to bridge them.

¹² Housing conditions: The human conditions within the physical state of a house.

The outcomes of this phase help to define the necessary key components of the design support.

The deliverables of the DS-I stage are (Blessing & Chakrabarti, 2009):

- A completed Reference Model, Success Criteria, Measurable Success Criteria and Key Factors
- Description of the existing situation and highlight the problems
- The relevance of the research topic
- Clarification and illustration of the main line of argumentation
- Identification of the factors that are most suitable to address in order to improve the situation
- An updated Initial Impact Model
- Implications of the findings for the development of support and/or for the evaluation of existing support

2.3.3 Prescriptive Study (PS)

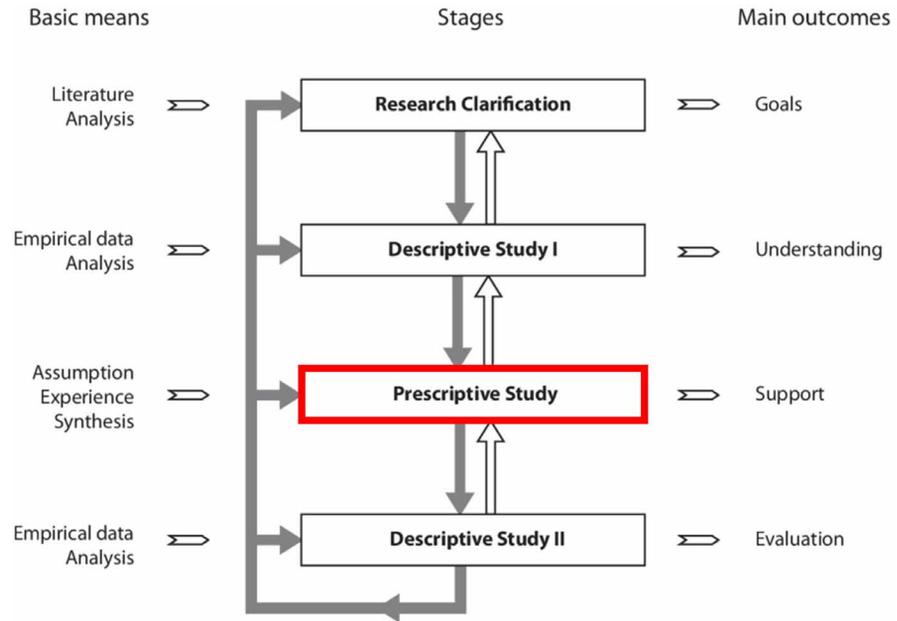


FIG. 2.7 DRM Framework (Blessing & Chakrabarti, 2009)

The PS1-phase (see Figure 2.7) confirms the capacity gap the inhabitants of Mt. Elgon experience in articulating improved housing by themselves. It concludes that the inhabitants rely on external professional support and advise in pursuing improved housing, moreover, it clarifies the key criteria for supporting professionals in advising inhabitants. The PS1-phase aims at converting these key criteria into an appropriate Support Tool in three ways:

- Firstly, by noting how professionals can approach a vulnerable context like Mt. Elgon,
- secondly, by demonstrating how professionals can evaluate inhabitant capacities and how they can be integrated into housing solutions,
- thirdly, by showing how professionals can effectively transfer knowledge about the housing solutions to the inhabitant(s).

The last section of the chapter provides the framework in which the impact of the support and the extent of its suitability can be measured. The DS2-phase explains the quasi-experiment in which the support will be tested. Moreover, it presents the impact of this experiment and the suitability of the Support Tool.

The deliverables of the PS-I stage are (Blessing & Chakrabarti, 2009):

- Documentation of the Intended Support
- Intended Support Description: what it is and how it works
- Intended Introduction Plan: how to introduce, install, customise, use and maintain the support as well as organisational, technical, infrastructural prerequisites;
- Intended Impact Mode
- Actual Support: workbook, checklist, software, etc.
- Documentation of the Actual Support
- Actual Support Description
 - The Support Tool, Appendix E:
 - In the support every page has a section in which the user can address the feedback
 - At the end of each chapter there is a section where the user can reflect on the chapter's suitability
- Actual Introduction Plan
- Actual Impact Model
- Outline Evaluation Plan

2.3.4 Descriptive Study (DS-2)

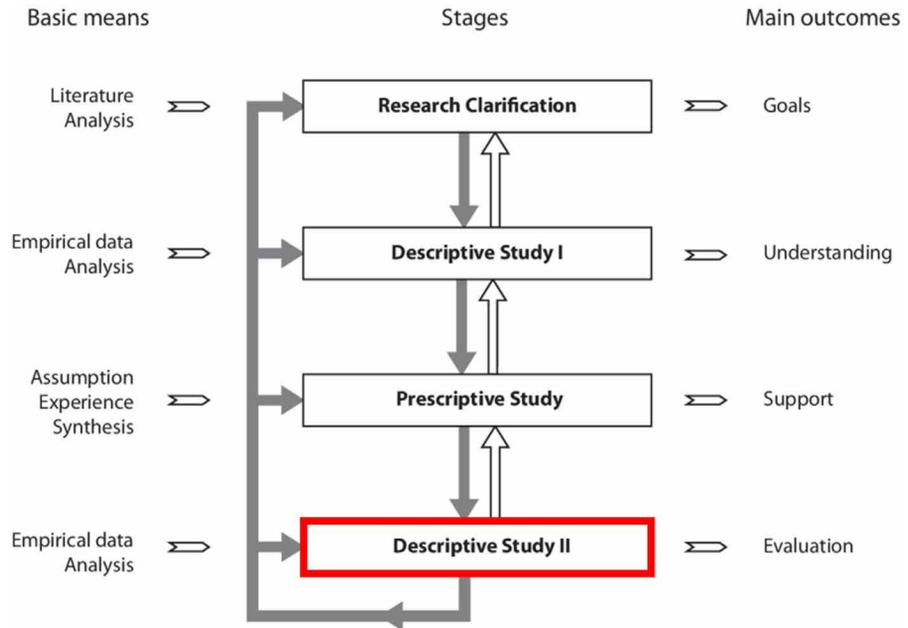


FIG. 2.8 DRM Framework (Blessing & Chakrabarti, 2009)

The PS1-phase describes the Support Tool and the evaluation framework to measure the impact of the quasi-experiment. The DS2-phase demonstrates how the articulated design support was tested on Mt. Elgon. In this quasi-experiment both professionals and students advise local inhabitants about articulating improved housing. The formulated evaluation cycle assesses the impact of the tool on the inhabitants' self-reliance, comparing their new and former housing situations. Moreover, it explains the effectiveness of the Support Tool for the involved professionals, suggesting possible additions and alternations to the support.

The deliverables of the DS-II stage are (Blessing & Chakrabarti, 2009):

- results of the Application Evaluation
 - Baseline measurement, interview guide (all groups), Appendix H
 - Impact measurement, interview guide (support groups), Appendix I
 - Impact measurement, interview guide (control group), Appendix J
 - Overview of the cross-referenced interview question with the impact model, Appendix L
 - Labelling questions to multiple factors
 - Cross referencing questions between traditional, current and desired housing
 - Example transcriptions of in-depth baseline interviews, Appendix M
 - Example transcriptions of in-depth impact interviews, Appendix N
 - Example observer sheets which helped to register questions during the interviews, Appendix O
 - Coding protocol, Appendix P
- results of the Suitability Evaluation
 - Feedback Survey support groups, how the suitability of the support can be evaluated through an online survey, Appendix K.
 - Questions which address user capacities prior to the quasi-experiment
 - Questions on the support's suitability during the quasi-experiment
 - Questions on how the user looks back at the suitability of the support to realize self-reliant housing
 - Questions which reflect on teamwork and its influence of the team's effectiveness
 - Overview of all the registered feedback by the users in the support tools, Appendix Q
 - Analysis of the feedback, Appendix R
 - How to treat feedback by the users
 - How to code the feedback
 - How to evaluate changes to the support.
 - Overview of the required adjustments to the support per chapter, Appendix S
 - Outcomes of the online survey, Appendix T & Appendix K
- implications and suggestions for improvement for:
 - the Actual Support
 - the Intended Support, its concept, elaboration and underlying assumptions
 - the Actual and Intended Introduction, Plan including introduction, installation, customisation, use and maintenance issues
 - the Actual and Intended Impact Model
 - the Reference Model
 - the used criteria

2.4 Research Overview, Research Questions and Goals

As explained in previous sections this research investigates a complex problem in practice which deploys a multitude of approaches and methods for its investigation. Figure 2.8, shows an overview of the research per stage with the corresponding Goals and the Research Questions. Two Research Questions: RQ1 and RQ2 are studied in the RC-phase of the DRM research based on literature review. These questions concern the type of knowledge that will be generated, moreover, when and how this has to be exchanged in a support team. Based on the outcomes of this phase Research Question 3 and 4 (RQ 3 -4) are developed. In the DS I-phase, RQ3 and 4 are answered and the remaining Research Questions RQ 5 to 9 are developed. The Hypotheses and the Measurable Criteria; as the DRM research prescribes; are based on the findings of the RC-phase. The overview of the layout of this research (Figure 2.8) is used in each Chapter to provide a guide and summary. This overview is used in the next Chapter to provide a guide and summary per stage and sub-stage of the DRM. The elements of the figure marked in yellow are the parts that will be addressed in that chapter (DRM-phase).

TABLE 2.1 DRM-stages with corresponding Research Questions and Goals.

DRM Stage	Research Question(s)		Goal
Research Clarification	RQ1	What are the main contributors to inhabitant's self-reliant housing?	Problem identification Hypotheses and Measurable Success Criteria
	RQ2	Are inhabitants able to articulate desired housing by themselves?	Addresses hypotheses 1,4,6 Answers RQ1+RQ2 Development of RQ3+RQ4
Descriptive Study 1	RQ3	Which factors hindered housing improvement?	Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4	What are the necessary key-components of the design support?	Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

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TABLE 2.1 DRM-stages with corresponding Research Questions and Goals.

DRM Stage	Research Question(s)		Goal
Prescriptive Study 1	RQ5	What helps in approaching a vulnerable context?	Goal A: Vulnerable context approach: Undesirable & desirable behaviour, appearance and communication Goal B: Vulnerable context methodology: Daily switching of actor & observer role
	RQ6	How can inhabitant capacities concerning their built environment be evaluated?	Framework for inhabitant capacity evaluation: Mixed method (interviews, observations, games & context mapping)
	RQ7	How can inhabitant capacities regarding their built environment be integrated in solution formulation?	Methodology for capacity informed decision-making.
	RQ8	How can the impact of the support be measured?	Framework for impact measurable (success) criteria: - Baseline in-depth interviews with inhabitants - Impact in-depth interview with inhabitants and community members
	RQ9	How can the suitability of the support be evaluated?	Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.
Descriptive Study 2	Test RC 1-9		Goal A: Evaluate support impact Goal B: Define the recommended adjustments to the support Verification of the Research Factors & Key-components
Conclusions			Verifications Hypotheses

Research Outcomes

In the following chapters the research project results per DRM stage are described and explained. The research outcomes consist of the answers formulated in reaction to the formulated Research Questions and Research Goals results.



3 Research Clarification

The previous chapter assessed the suitability of the DRM for this research project. According to the DRM, the research is divided in four phases, starting with the Research Clarification, presented in this chapter. This chapter points out that the inhabitants of Mt. Elgon are not able to articulate self-reliant housing solutions without external help. It assesses what constituted self-reliant housing in the past and how this relates to current housing. The first part offers a detailed description of the case (Mt. Elgon) and its relevance to comparable communities in Sub-Saharan Africa. The second part discusses the inhabitants' ability to articulate self-reliant housing. The outcomes of the first two parts were published in the proceedings of *Tradition and Heritage in the Contemporary Image of the City*¹. In the third part, the inhabitants' ability to articulate improved housing is compared between various communities on Mt. Elgon. This section concludes by explaining the importance of self-building practice as a contributor to self-reliant housing. The fourth part describes the status of inhabitant capacities as the main contributor. The outcomes of these two parts were published in the *International Journal of Sustainable Development and Planning*². The fifth part concludes the chapter by answering the first two research questions.

¹ Smits, M. (2014). An architect's investigation into the self-reliance of a Sub-Saharan African community. In E. W.-S. Tomasz Jeleński, Stanisław Juchnowicz (Ed.), *Tradition and Heritage in the Contemporary Image of the City: Monograph. Challenges and responses* (pp. 119–125). Krakow: Wydawnictwo PK.

² Smits, M. (2017). Formulating A Capability Approach Based Model To Sustain Rural Sub-saharan African Inhabitant's Self-reliance Towards Their Built Environment. *International Journal of Sustainable Development and Planning*, 12(2), 238–251.

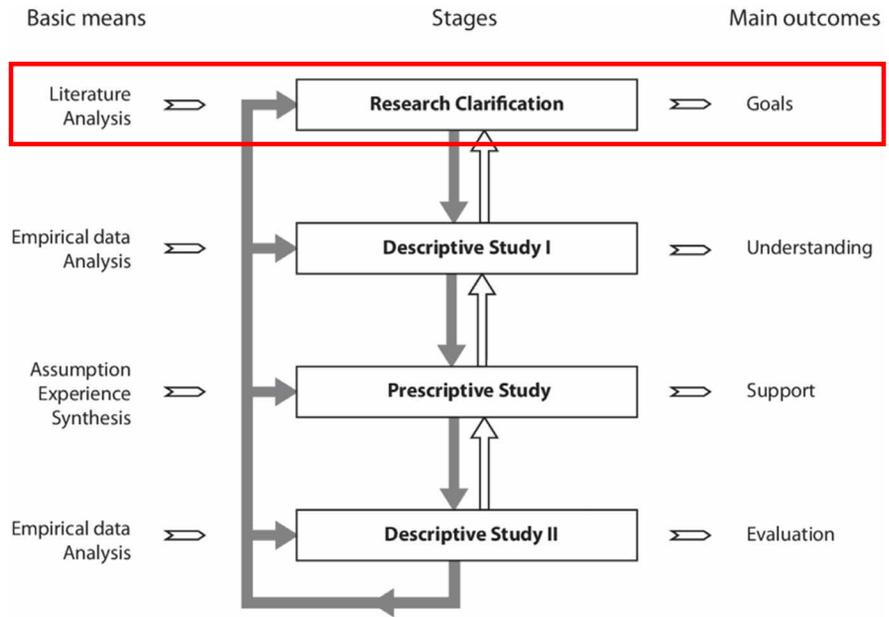


FIG. 3.1 DRM Framework (Blessing & Chakrabarti, 2009)

TABLE 3.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)		Goal
Research Clarification	RQ1	What are the main contributors to inhabitant's self-reliant housing?	Problem identification Hypotheses and Measurable Success Criteria
	RQ2	Are inhabitants able to articulate desired housing by themselves?	Addresses hypotheses 1,4,6 Answers RQ1+RQ2 Development of RQ3+RQ4
Descriptive Study 1	RQ3	Which factors hindered housing improvement?	Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4	What are the necessary key-components of the design support?	Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

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TABLE 3.1 DRM-stages with corresponding Research Questions and Goals

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	RQ9	How can the suitability of the support be evaluated?	Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.
Descriptive Study 2	Test RC 1-9	Goal A: Evaluate support impact Goal B: Define the recommended adjustments to the support Verification of the Research Factors & Key-components	
Conclusions		Verifications Hypotheses	

3.1 Urban and rural self-reliant ‘informal’ housing

With roughly 65% of the world population with an income below \$2,000 per year, currently over 4 billion people are at the financial Bottom of the Pyramid (BoP) (Prahalad & Hammond, 2002). Although effort is being made to understand slum conditions and solutions (Bird, Montebruno, & Regan, 2017; Simonelli et al., 2013; UN-Habitat, 2003), little attention is paid on how with minor interventions the security and general Quality of Life (QoL) can be improved. Exponential population growth has forced many rural inhabitants in developing countries to urbanize (UN-Habitat, 2013), in most cases in search for better opportunities (UN-Habitat, 2014). Thousands of new “informal” houses are built every day to accommodate this vulnerable group. According to UN Habitat at the moment over 70% of family housing worldwide is built informally and often by the inhabitants themselves. Roughly 60% of these families are located in informal neighbourhoods (UN-Habitat, 2013). In these residential areas inhabitants have no security of tenure, lack basic services, and the housing does not comply with the building regulations. Slums are the most deprived and excluded form of informal housing (UN-Habitat, 2015) slums, slum dwellers, vulnerable and marginalized groups, socio-spatial exclusion, governance, equity and equality, environmental justice, participatory planning, right to adequate housing, security of tenure, slum upgrading and prevention, inclusive finance, informal economy MAIN CONCEPTS Informal settlements – are residential areas where 1. Due to the lack of land, financial capacity and planning these areas become particularly dense housing districts. Global urbanization figures estimate that 60% of world population will live in cities by 2030 (Cohen, 2006), with Africa being under the most significant shift from rural to urban in the contemporary world (Raleigh, 2015). Namely the rapid growth, sheer size and density of the slums will impose a great danger to the general QoL and safety of the urban BoP (UN-Habitat, 2014). The scarcity of social and spatial organization in slums is leading to degradation of the standard of living and security (UN-Habitat, 2014). This stresses the emergency of researching the main contributor to informal urbanization, namely: rural-urban migration (Tacoli, Mcgranahan, & Satterthwaite, 2014). This shift has posed a great threat to the wellbeing of vulnerable families in the past and can only predict the problems ahead. In Africa, projections are that over half of the urban population (61.7%) will live in slums and by 2050, Africa’s urban dwellers are projected to have increased from 400 million to 1.2 billion (UN-Habitat, 2015; United Nations., 2012){“id”:“ITEM-2”,“itemData”:{“abstract”：“Urban poverty, slums, slum dwellers, vulnerable and marginalized groups, socio-spatial exclusion, governance,

equity and equality, environmental justice, participatory planning, right to adequate housing, security of tenure, slum upgrading and prevention, inclusive finance, informal economy MAIN CONCEPTS Informal settlements – are residential areas where 1. Therefore, this research focusses on housing in rural-urban migration in Sub-Saharan Africa as it contributes to the fastest urbanizing areas on the continent. With 20-25% of the countries' population urbanizing in the next 20-30 years (World Bank, 2016) Kenya proves to be representative case.



FIG. 3.2 (left to right): Urbanization index (World Bank, 2016), location of Mt. Elgon in Western Kenya and location of selected communities

In particular West Kenya has a large number of growing cities Kisumu, Eldoret, and Nakuru (World Bank, 2016), which is also called the 'western hub'. In the left image of Figure 3.2 this urbanization is projected. Here, Mt. Elgon is one of the rural areas that potentially hold many rural-urban migrants, which sadly became clear during the last chapter of Kenya's political violence (UN-Habitat, 2008). With generally low incomes, poor infrastructure, and lack of employment, the Kenyan postelection violence in 2007-2008 was for many rural inhabitants the final push to migrate to the city. Due to ethnic violence in Endebess many of its inhabitants fled to Kitale or Eldoret. Thus, providing a viable research area for investigating rural to urban migration in relation to inhabitant's level of self-reliance regarding their housing. The author was involved in realizing improved housing on Mt. Elgon (part of Endebess county) and therefore has the network and infrastructure to study informal housing in great detail. Here the transition inhabitants experience from traditional (wattle and daub-based) towards improved (industrialized materials) housing can be observed. In the following section the background of the case and its locality are introduced.

3.1.1 Background of the case & locality

This section addresses the observations the author made prior to the start of this research project. Here, initial (unstructured) interviews, case-studies, and a participatory game were conducted to analyse self-reliant housing and which factors hindered the realization of improved housing in the specific rural-urban migration context of Mount Elgon. Since 2008 the owners of Mount Elgon Orchard limited (Mt. Elgon Orchards, 2018) developed multiple social projects for the surrounding rural communities of their farm (see Figure 3.3). Although not yet a licensed architect, the author designed several of these projects on Mt. Elgon. These projects erroneously excluded the inhabitants from the design and construction process. The observations and interviews in the next section will show how the spatial intervention (project realization) lead to a multitude of social and cultural problems. Here, inhabitants are studied in their current (traditional) housing and compared to families living in improved housing. For the latter a large housing project realized by Habitat for Humanity on Mt. Elgon, was chosen. What follows is a brief description of the case to pinpoint important factors that hindered the project's success.



FIG. 3.3 Left complete staff, Right the farm and informal settlements (author: M. Smits)

As the farm is located in an isolated area bordering Uganda, most of the workers have been living at the perimeter of the farm for generations. These informal settlements rapidly grew in size and number, causing the deterioration of the living quality. Due to the spatial constraints there is a lack of water, sanitation and privacy. Therefore, the farm owners wanted to realize a neighbourhood of 96 improved houses for their workers. Here, the farm, trust and NGO (Habitat for Humanity) positioned themselves as the developers of a turnkey housing project, where they made most of the design-, engineering-, materialization-, and construction decisions without the involvement of an architect or its future inhabitants. The author has

gotten involved after the design of the house was finalized and only requested to make an improved masterplan for the 96 houses.

In the traditional housing situation, the various families would have decided on the house design by themselves and debated its positioning with their neighbours and community. In the Habitat for Humanity housing project the involved families were excluded from these processes. When asked why the initiators excluded the inhabitants from the housing project, they answered that they had to finish the project as soon as possible. They signed a two-year financial contract to realize the project and at that point they had to finish within a year. Involving the inhabitants would be time consuming and thus they were excluded. This led to spatial insensitivities (addressed later in this chapter), that might have been prevented if the inhabitants were involved in the design, detailing, costing and realization process of their new houses. However, the initiators and author lacked knowledge and access to appropriate tools to include inhabitants in the available timeframe. Although efforts were made by the author to understand social and cultural values through traditional methods (mapping, typological research, etc.), they capture the inhabitant's preferences insufficiently and still mainly excluded them from the realization of their houses. The most significant effect of this process is the inability of the inhabitants to maintain, extend or replicate their houses. Not only does the majority of the inhabitants lack the funds, but more importantly they lack the tools, knowledge and skills. These three aspects are considered to play an important role in constituting self-reliant housing solutions (investigated later in this chapter) and are therefore called inhabitants housing capacities. The next section will elaborate further on the importance of knowledge and skills for inhabitants to articulate self-reliant housing.

3.1.2 **Inhabitant housing capacities: knowledge & skills**

In the housing tradition on Mt. Elgon, the community acted as a collective to help each other realizing housing. Family members evaluated their family's housing requirements and constructed it collectively with their community, which makes it one of the longest lasting human artefact (Cole, Leaman, & Seaden, 2000). Families were able to live self-reliantly although interdependent on neighbours and other families of their community. This group of families shared knowledge, labour, tools and materials, realizing and improving their archetype over time. As a result, traditional housing breaths the community's common goal regarding housing which Leimeister (2010) also calls 'collective intelligence'. Enabling them to collectively share, learn, and adapt their housing to a continuously changing environment, making them highly resilient towards challenging circumstances.



FIG. 3.4 Various Communities of practice (CoP), Mt. Elgon, Kenya, 2011 (author: M. Smits).

The collective knowledge of traditional housing is mainly ‘tacit’ knowledge (Polanyi, 2012), articulated in all spatial processes and products. It is not a model or a framework but a way of learning that occurs in the everyday (see Figure 3.4). A form of learning which adapts dynamically to changing circumstances, also called situated learning (Cobb & Bowers, 1999). As the majority of inhabitants still live in self-built houses erected with locally acquired materials, the sustainability of the current externally led development is queried. According to Kinsbergen (2014), inclusion of the community in the project as a whole (finance, initiative, decision-making, ownership, construction and maintenance) is a key component for its success. The DS1-stage will analyse and compare existing support tools in their ability to offer self-reliant project solutions. Identifying support tools which benefit the exchange of explicit knowledge from professional to non-professional (read non-local to local) and tacit knowledge from non-professional to professional. Knowledge exchange would both increase the compatibility of the articulated building solution in its context and the inhabitants’ ability to sustain it. It would apply in all phases of the project, from initiation to maintenance, as well as increase involvement of local inhabitants in realizing improvements to their built environment (Groat & Wang, 2002).

However, before such methodology can be investigated two questions need to be answered first:

- Are inhabitants able to articulate desired housing by themselves? (RQ1)
- What are inhabitant’s main contributors to self-reliant housing? (RQ2)

3.2 Inhabitant ability to articulate housing (traditional & desired)

This section describes approaches previously preliminary executed by the author, within an action research framework. Investigating what contributed to self-reliant housing in the past and to what extent this is projected in the on-going development on Mt. Elgon. This section consists of six parts starting with the housing mapping³ performed in the area. Here, mapping is used to understand the general living situation, investigating the community size, housing typology, general infrastructure and places of importance. Secondly, exploratory interviews are held to retrieve more detailed information of the inhabitants that applied for the housing project. Here topics such as family size, income, religion, etc are covered to get a first impression of the community's composition and general capacities. Thirdly, multiple observations are conducted to increase understanding of the existing inhabitant capacities in relation to their current housing. For example, exploring the specific position of the houses and how this related to the program in and around the housing. Due to the overlap of spatial preferences between the observations, the fourth part describes a boardgame exploring these on a larger (community) scale. Investigating if individual community members have a comparable notion where certain services (school, church, etc.) should be located. The fifth part describes the problems observed in the Habitat for Humanity project and how these relate to other examples of realized improved housing in the area. The last part describes the findings of this section and reflects on the inhabitants' ability to articulate traditional and desired housing.

3.2.1 Mapping: the camps

Around five hundred families live in the perimeter of the farm (see: Background of the case & locality), divided over several camps in informal settlements. A map made by Mt. Elgon Orchards (Figure 3.5, right image) was available to the author, however, when starting the mapping process the author noticed many houses were missing and the map lacked precision. Based on the author's investigation (completed in 2008) information was gathered on infrastructure, rivers, type of housing, number of residents per house, shops, bars and farmland (Figure 3.5, left image).

³ Mapping: understood as a clear spatial analysis in plans and text of the location



FIG. 3.5 Existing urban fabric camps (author: M. Smits)

The outcomes show that although there is a large variety in housing types and forms, the used materials and construction methodology are largely the same. The majority of houses were constructed by inhabitants themselves and almost solely consisted of local, affordable and renewable (natural) materials. The next section will investigate inhabitants' current capacities and their motives for desired housing.

3.2.2 Exploratory interviews

To increase understanding in the existing inhabitant capacities, semi-structured interviews were conducted (see Figure 3.6). The interview questions addressed demographical topics to understand the inhabitant's: income, family size, size of the house, etc. Under supervision of the author, in a two-day session (08-11-2008/09-11-2008) three farm managers took the first interviews with 15 respondents (workers of the farm) that wanted to apply for a new house. It is important to state that only inhabitants of the camps were able to apply for a new house and were amongst the first to be relocated from the camps to the new village⁴. Parallel to the inhabitant's interviews several interviews were conducted with the farm staff involved in the development projects (both owners and 3 management members of the trust, were interviewed over several days 10-2008). In the interview evaluation the interviewers indicated that the respondents had privacy problems due to the location (at the new village site), the author's presence and the selected interviewers, which led to short and undetailed information. To solve these problems the second session had a random sample (10 respondents, on 14-11-2008) and after also these interviews gave disappointing results, the interviewers were changed as well.

⁴ The new village: locally used name for the Habitat for Humanity housing project

The three new interviewers were teachers at the primary school and considered trustworthy (in the eyes of the community), moreover, they were trained as social workers. Without the physical presence but under the supervision of the author the interviewers were visiting the respondents (20) at their homes (on 19-11-2008). This had a major effect on the outcome of the interviews and the collected data was used to evaluate the respondent's demography, general background, customs and traditions as shown below. Due to the setting of the interviews, the sample size and the exclusion of ethical procedures, the data (see Figure 3.6) can't be presented as a part of the overall research. In the DS1 phase a more elaborate survey will be executed to correctly determine the level of self-reliance regarding their existing housing and which barriers they experience in articulating desired housing. However, some of the outcomes are significant to indicate the current capacities of the inhabitants. For example, the low- and fluctuating-income levels (below the international poverty line), an average high number of family members and low number of square meters per household.

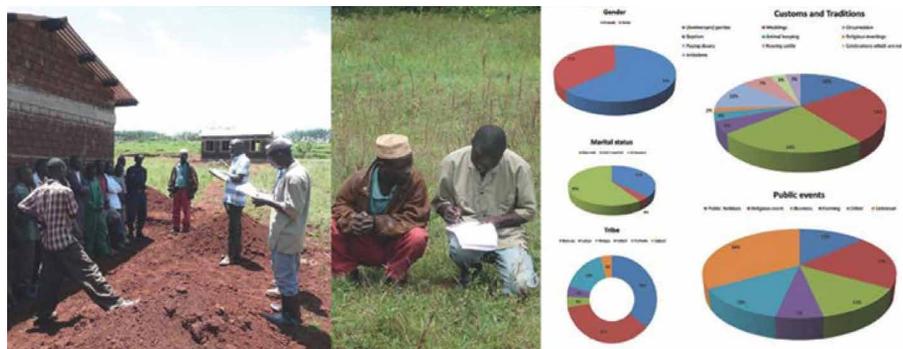


FIG. 3.6 Pictures interview session I&II + demography (author: M. Smits)

Without the analysis of the family's existing spatial situation it is difficult to interpret the demographical outcomes. Therefore, the next section describes multiple observations performed within the community, to correlate the outcomes with the spatial and cultural consequences.

3.2.3 Observation I Mount Elgon

The aim of this section is to contextualize how the findings of the interviews correlate to daily life in and around inhabitant's houses. Researching the social and economic dimensions of the existing housing patterns. Moreover, what constitutes to their current level of self-reliance regarding their housing and identify if the family is able to articulate improved housing by themselves. To gain sufficient understanding on functions and usage of space in a brief period of time, participant observation was chosen. This form of observation allows to engage with the participants during the observation (Hennink, Hutter, & Bailey, 2010). Enabling the researcher to participate in everyday activities and ask questions when needed. The family (Figure 3.7) was selected randomly in the local community (the father of the family was passing by on the road). The family was informed on the goal of the observation: to understand local everyday family life and how they use the family compound space, in the image below the observed family on Mt. Elgon. The observation took place on 23-11-2018 from 4:30 in the morning, till 22:00 in the evening. A local social worker (Geoffrey Ngeywa) was present to make the family feel comfortable and translate when needed.



FIG. 3.7 The first family (author: M. Smits)

The observation started with making a full inventory of the houses, the house on the middle (also see Figure 3.9) is the main house (Left image, Figure 3.8). In this house the parents live together with their 8-year-old daughter Martha. The left side of the house is reserved for sleeping where two beds are placed. Cloths are used to make a temporary separation between the two bedrooms (Parents' and Martha's). These cloths are moved if the interior program of the house needs to be changed due to visitors or important events, allowing the individual spaces to expand or shrink according to the daily requirements of the family. Next to the beds large bins are placed for storage purposes. In total this almost covers half of the family house, the other half is used as living space.

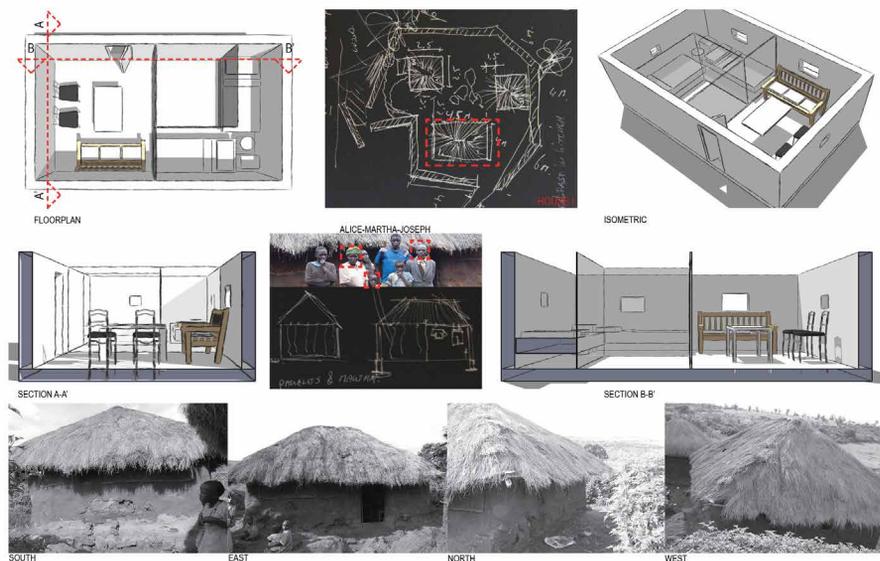


FIG. 3.8 Inventory of the houses: floor plan, sections and facades (author: M. Smits)

Mapping the family compound is meant to gain better understanding of the spatial consequences of the current social/economic development of the family. Moreover, detailed day-schedules for every person were written. Compared to other households this living room (1.4) is special as it is furnished with a couch, chairs and large table. Having this living space tells something about their level of income. The only other known examples of this kind of living space are at the houses of the chairman, pastors or people that have a well-paid job at the farm.

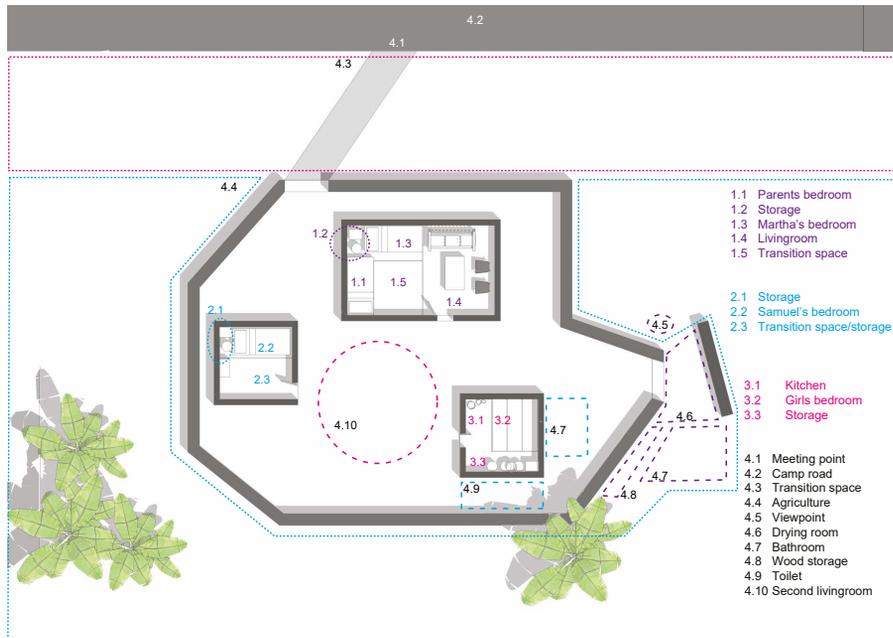


FIG. 3.9 Family compound, with program and usages (author: M. Smits)

The house on the left side (Figure 3.9) belongs to Samuel, he is seventeen and supposed to live independently. Compared with the kitchen/bedroom of his sisters his house is 'luxurious'. Not only does he have a bed and small cabinet to store his clothes, he also has a bicycle. His house is divided into two parts (2.2 & 2.3) by a thin cloth. The rest of his house is used as storage space (2.1). The building on the right side (Figure 3.9) is the kitchen space, which also functions as the house for the girls. During the day sleeping materials are stored on the backside and the kitchen has full working space (3.2). At night mats are rolled out and a mosquito net is hung above the beds of the girls. The net is the only one the family has, in this house there is no separation between the different functions and most space is currently used for storage.

The compound is fenced with a low green hedge with a small path leading to the main road. Round the family compound there are also different outdoor functions. These are not clearly defined, but used for a specific purpose, and are for that reason marked with a dotted line. The central circular space (4.10, Figure 3.9) is the place where the family gathers and eats. This place is also used to dry maize, to prepare all kinds of products for cooking, and also just to sit and talk. Behind the kitchen space (4.7) there is an area to wash oneself out of sight of others and on

the other corner a place to wash clothes. The right edge of the family compound is used for drying clothes (4.8), growing vegetables (4.5) and for midnight sanitation emergencies (4.6).

From this observation some of the key components of the family's movement and spatial organization became clear. More importantly where and when daily activities met with other neighbouring families. One of the key values is the main road (Figure 3.9) that runs through all the camps. It is used by the farmworkers to go to work together in the morning, but also for children to walk to school together. Another important place of social activity is the water source, where children from all ages meet each other throughout the day.

The image below (Figure 3.10) visualizes communication, movement and usage of the families' outdoor space. It's indicating movement patterns of the individual family members during morning, afternoon and night. Here the physical movements are expressed in straight lines and visual/verbal communication in dotted lines. It becomes clear that the central outdoor living area is most used throughout the day. Their individual orientation plays a vital role in both their internal and external routing and communication.

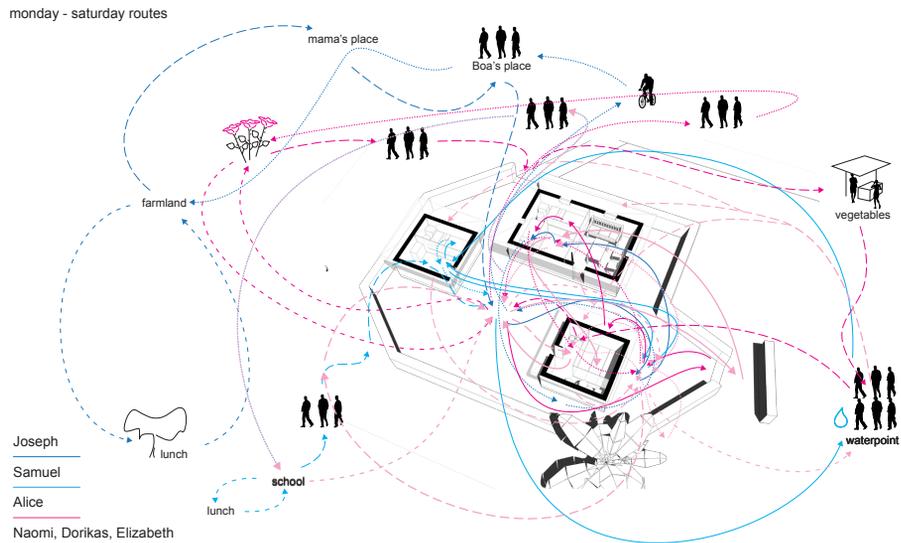


FIG. 3.10 Patterns of movement and communication around the family compound (authors: B. Duda & M. Smits)

The analysis shows the great significance of having separate house structures⁵ so children from a young age are taught to be self-reliant and how to become an adult within the safe borders of the family. Moreover, they enable an indirect communication with the public realm. People passing by can see a glimpse of the family or hear them talk. Making it easy for people to engage with the family (ask how they are doing or if they want to join an activity). This transitional space between the public (road) and private (inside the houses) is what the author calls: shared space. Shared not only by the family members, due to its low visual threshold (low fence & open-air activities), with community members. The main findings of this observation are combined with those of the second observation and presented at the end of the next section.

3.2.4 Observation II Mount Elgon

In order to correlate the findings of the first observation a second observation on Mt. Elgon was conducted on 26-11-2008 (see Figure 3.11). Here a family was selected with comparable capacities however living in a different community. Although the observation followed the same methodology it emphasized more on the time schedule of the family, aiming to increase the understanding of shared activities with other community members and where these take place. It allowed a more in-depth analysis of where activities took place outside the family compound and possibly analyse shared activities between community members.

The family members explained their weekday and weekend activities, the translation of this movement is shown below. This family lived slightly more remotely in the Lokobo II camp. Situated rather far from the main road, didn't work for the farm and only had one direct neighbour. Although some differences were observed, many spatial customs (family house and kitchen usage) were comparable to the first case study on Mt. Elgon. Despite that the core of the family wasn't next to the road it functioned in a similar way. Neighbours were seen in everyday life and most family members participated in each other's daily chores.

⁵ Separate house structures: if the household consists of more than one structure.

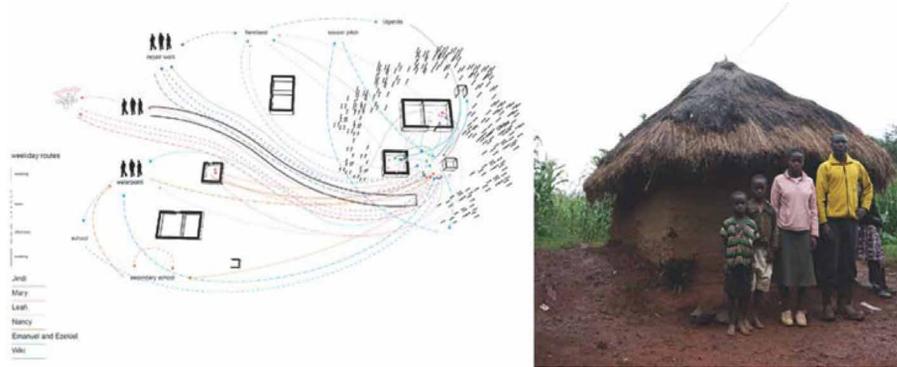


FIG. 3.11 Left spatial 3d scheme, right the family (authors: B. Duda & M. Smits)

The gardens, also called Shamba, play a key role in the vitality of the camps economy and sustaining enough food resource. Because most households have one parent that work on the farm the other parent is in most of the cases working on farmland in or outside the camps. This is also an important social aspect as men and women often work together on the lands. In exchange the workers receive payment either in the form of money or food. Most siblings above 18 are not in secondary education (in most cases due to the lack of finance). Most of them take on small daily jobs for food a small financial compensation. This is not enough to sustain their own life (food, habitation, etc.) and this live longer with their parents then normally would be the case. Because the siblings stay longer with their family, they find a stable income later, marry older and get children later.

The outcomes of both observations show that families are able to maintain their existing house by themselves. Not only do they share the knowledge and skills with their community, they also have the tools and materials available. Repairs of floors, walls and roofs are needed frequently, but as the family has access to the tools and materials, they have a relative high level of self-reliance regarding their housing. When asked if this is the housing type they prefer, the families answer that they would desire larger and more permanent housing. Although the family has a clear idea of desired housing, their current capacities do not meet the required knowledge, skills, tools and materials to realize desired housing by themselves. A tendency which is observed across the community.

Comparable to the interviews, the sample size for the observations is small and not representative for the community. The outcomes are therefore merely meant to identify the trends which later in the research can be studied in more detail. In the DS1 phase a more elaborate survey is executed to correctly determine the level of self-reliance regarding their existing housing and which barriers they experience in articulating desired housing.

3.2.5 Board game: The dream village

Interviews and observations increased the insight into societal and spatial tendencies within the informal built environment on Mt. Elgon. More importantly the observations showed that the families had a similar understanding of where and how the house needs to be oriented towards other families and the public spaces, indicating that there might be a tacit understanding of how the community articulates their spatial organization of the family compound, neighbourhood and community. To understand how the inhabitants would plan a new village by themselves a game was developed in which they were able position the various functions. Comparing the outcomes of various inhabitants exposes the similarities and differences in spatial preferences. Correlating these results with the masterplan of the Habitat for Humanity project, exposes the planning mistakes of this project.

The 'dream village board game' took away the stress experienced during the interviews and give people the opportunity to show how they would spatially organize their future village. For three days (02-12-2008/04-12- 2008) the board game was played with fifteen respondents living inside the current camps (see Figure 3.12). The board was covered with a map of the "new village" location. The game was explained by a local social worker and because map reading is difficult for most inhabitants, the road to Suam, the Kaptega River, and marketplace were indicated to them.

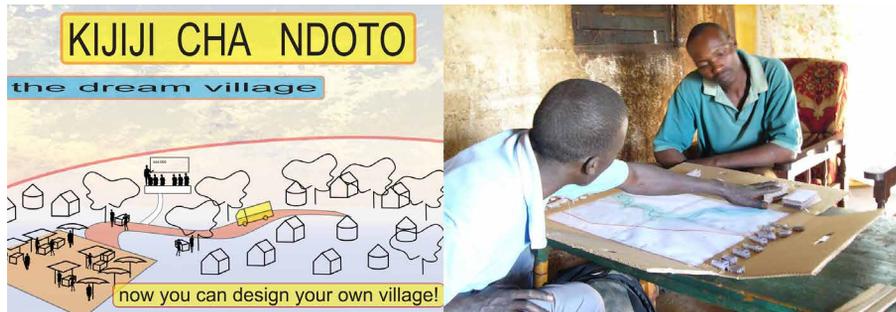


FIG. 3.12 Left the cover of the board game, right one of the participants (authors: B. Duda & M. Smits)

The board game pieces consisted of houses, church, marketplace, water-collection-point, school, chairman, bush shops, etc. All the correspondents showed their preferred village organization without knowing or seeing the results of other respondents. The board games were supervised and observed by the author and performed by a community worker at the respondent's homes.

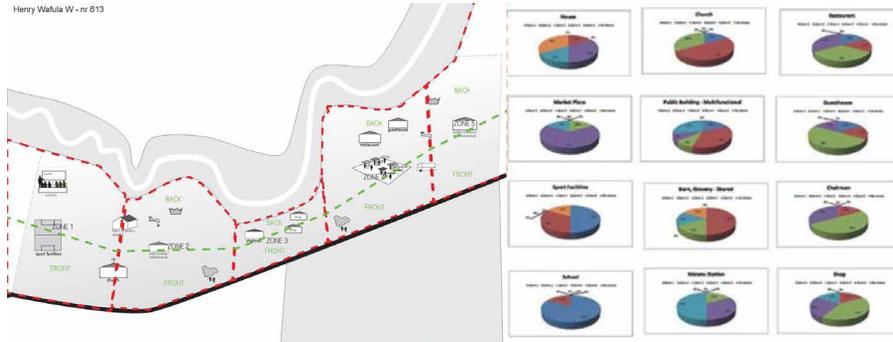


FIG. 3.13 Left one of the results, right the outcomes of all games played (author: M. Smits)

For every contestant photographs of the final solutions were made. Dividing the map into 5 zones (shown in the image above) enabled the comparison between the respondents (Figure 3.13). From the first analysis it became clear that every participant placed the public functions in the same zone. Indicating that although the participants have a different background there is a common notion of the position of public functions. Illustrating that the community might have a common logic of organizing their public space and that ignoring it (as seen in Habitat for Humanity project) has potentially problematic consequences.

3.2.6 Problems of the Habitat for Humanity project

Figure 3.14 shows the contrast between the construction methodology of the camps (left) and that of the introduced housing (right) in the new village. The camp houses are constructed by its inhabitants, using available tools and materials: hardwood, pine, soil, cow dung and thatch. The new housing is constructed by hired labour, using expensive tools and materials: concrete, steel, cement, river sand and ballast. Beside the increase of hired labour and bought non-local materials there are also examples of spatial problems that influence the sociocultural behaviour in and outside the new housing. For example, in the new housing, inhabitants are allowed to construct only one house, as a result the families have to accommodate all their children in one house. Forcing their sons to live under the same roof which is after their circumcision normally not allowed.



FIG. 3.14 Left camp housing typology, right “new village” typology (author: M. Smits)

Taking a look at the programme of the housing, some more severe changes are observed. While in the existing settlements the interior separations were made by clothes, in the new housing, walls are employed to separate the different programs. Consequently, the house loses its flexibility and inner social climate. Traditionally, the inhabitants would change the interior program between day and night, but more importantly to accommodate visitors, constantly readjusting to the changes of everyday life and its spatial requirement. In the new housing typology, the rooms are fixed and can be closed off from family life. Where traditionally an average family would have between 60 and 100 square metres of programme, this is now reduced to a mere 30 square metres. For the families that have over 6 members (the majority of inhabitants have extended families) it is impossible to fit the family into the new house. As a result, young children are forced to live outside the family compound in Chepchoina (a nearby village). In the light of recent events this has threaten their wellbeing, as without parental care and control (exposing them to alcohol, drugs and violence).

Where, in the camps, the outdoor living room was semi-enclosed from the public and in this way partially maintained the privacy of the family, it is now fully exposed to public life. In the last observation an increase of time being spent inside the family structure instead of being outside can be seen. This causes a further increase of privacy and has possible negative effects on social transparency within the community. This should be a choice that the family or community makes based on their social preferences. Over centuries rural community regulations provided guidelines for the spatial organization. With the introduction of governmental and farm regulations these guidelines do not apply anymore. Where traditionally the chairman and village board tacitly handled the spatial regulations⁶, they are now stated in a contract, unbeknownst to most of the inhabitants.

⁶ Spatial regulations: the changes inhabitants are allowed to make to their housing.

Cooking is another important part of the compound program. Traditionally the inhabitants cooked outside, however the new housing only have indoor kitchens. Although making tea and porridge inside, the majority of cooking activities in traditional housing still takes place in the centre of the family compound. This is often a second, partially enclosed living space, where the family meets neighbours to jointly prepare vegetables and such. However, cooking outside is perceived as a fire hazard by the developers. For this reason, the developers provided a kitchen inside the new houses. The inhabitants perceive cooking inside as unacceptable, and therefore refuse to use the indoor kitchen. After making this observation an outdoor kitchen was added to the house design. Traditionally the kitchen was in a separate structure in the homestead, which was not allowed by the initiators. Figure 3.15 shows: left the traditional separated kitchen (Butula), in the centre, the habitat for humanity project and on the right the comparable situation in the city (Kitale). Indicating that although an attached kitchen is not preferred, in urban cases similar solutions can be observed.



FIG. 3.15 Left: kitchen traditional homestead, centre: "new village", right: city typology (author: M. Smits)

Another example on how private functions are positioned in the public is sanitation. In the sanitation units of the new housing, the toilet and shower were combined and positioned on the edge of the family compound. However, soon after realization, inhabitants started to erect light structures closer to the house where they would bath. Indicating that their preference diverges strongly from what was actually realized. All these problems could have easily been prevented if the inhabitants participated in the design and realization of their housing.

3.2.7 Ability to articulate self-reliant housing on Mt. Elgon

The rural community of Mount Elgon is currently on a large intersection of their development path. Although many housing solutions were considered there are generally three solutions that the communities apply in this area.

Firstly, traditional housing, is one hundred percent bio-based (renewable resources), completely self- built and tends to be constructed with large sense of communal values (Njoh, 2016). However, the roofs often leak, the house is not burglar-proof, materials are increasingly difficult to get, the houses require a lot of maintenance and is prone to having rodents. The inhabitants of Mt. Elgon struggle to improve the traditional housing to meet their current requirements.

Secondly, modern housing, is built by hired carpenters and builders, and based on expensive materials and tools. This type of housing requires little maintenance (often called locally a permanent housing), is very durable and does not have rodents. For these reasons for the majority of the inhabitants this housing is currently preferred. However, this housing is not financially accessible for the majority of the inhabitants, requires hired labour for maintenance and has poor climatological qualities (hot in summer & cold and noisy in winter).

Thirdly, improved traditional housing are the existing traditional houses to which improvements have been made. In this type of housing the inhabitants mainly make modifications to the roof, doors and windows, sanitation, and electricity. For example, if there are sufficient funds to buy a roofing sheet, the grass roof is replaced step by step. The modifications contribute to the improvement of the housing quality one step at a time. Inhabitants often make the improvements by themselves or hire a carpenter for a day to instruct them. However, the traditional housing construction lacks accuracy which industrialized materials require. As a result, applied improvements buckle or corrode much faster when applied in a completely new built house.

The inhabitants on Mt. Elgon have the ability to build traditional housing by themselves, resulting in a high level of self-reliance in relation to their housing. However, the inhabitants do not desire this type of housing. The improvements made to the traditional housing, do no suit the characteristics of the used construction materials, decrease the level of self-building, and would require a more holistic approach. The holistic improvement observed in the modern housing examples on Mt. Elgon is only accessible for the happy few and almost completely removes the self-building practice of the community. Creating a high dependency on hired labour and a stable income which, the majority of the inhabitants do not have. Improved

housing solutions offered (Habitat housing project) by external stakeholders do not meet the preferences of the inhabitants. Moreover, disable (available: money, materials, skills and building knowledge) the inhabitants to maintain, extend or replicate the improved housing solution.

Concluding, if the inhabitants are to sustain their self-reliant housing practice in articulating desired housing, they require professional support. Support which enables the inhabitants to weigh the housing improvements against their existing material and financial capacities. This professional support will need to consider a complex number of factors: inhabitant preferences, program, sociocultural, material and building knowledge. A complexity best matching the role of an architect (Burr & Jones, 2010; Kahn, 1979). To better understand the importance of inhabitant capacities, the next section investigates them as main contributor to self-reliant housing solutions.

3.3 Existing capacities main contributor to self-reliant housing

As previous section explained, the model of vernacular construction processes reveals itself as an example of collective learning (Cobb & Bowers, 1999). This model is transferred by every generation, based on legitimate peripheral participation (Etienne Wenger, 2010). This participation consists of various tasks, such as: water fetching, mud mixing, wall filling and rope making (Figure 3.16).



FIG. 3.16 Various Communities of practice (CoP), Mt. Elgon, Kenya, 2011 (author: M. Smits)

Every task is performed by a mixed (age) group of participants and varied skill levels can be distinguished (from novice to expert). This group is what Lave and Wenger call Communities of Practice (CoP). The participation in a CoP according to Wenger (1998) is not only a shared activity but it encompasses a shared interest, which can involve people in any type of activity. These activities do not only concern the construction of buildings but range in all aspects of everyday life (like: washing, bathing and cleaning). Every such activity can be reduced to three basic elements (Etienne Wenger, 2010):

- 1 “What it is about”
- 2 “How does it function”
- 3 “What capability it has produced”

Capability generally means the quality of being capable; capacity; ability (Cambridge, 2020). In this section capability is analysed to understand the fundamental capacities which constitute to the CoP activity in providing self-reliant housing in Sub-Saharan Africa (Willer, 2002). An important departure point for understanding housing capability is through the Capability Approach (CA) theory. Here Sen describes capabilities as a person’s ability to achieve a given functioning: doing or being (1993). Sen formulated an alternative framework to look at poverty, inequality and human development in general (Clark, 2005). Although the capability approach is a normative economic framework it enables the assessment of general human well-being. However, there are few research examples which applied the CA for the evaluation of a group’s decision-making or evaluation process (Robeyns, 2011), specifically concerning housing. Li’s and Ng’s (2014), investigation seems one of the few examples that applied the CA in evaluating realized buildings. They formulated a list of capabilities and listed correlating factors (Figure 3.17). As explained in the previous sections they clearly made a distinction between self-reliance- and development capabilities:

RBESAS	Self-reliance capability	1. Land & resources conservation	1.1 Sensitive areas conservation 1.2 Agricultural land conservation 1.3 Soil and water conservation
		2. Waste management	2.1 Construction & demolition waste management 2.2 Operation waste management
		3. Pollution control	3.1 Pollution-free construction & demolition 3.2 Pollution-free agriculture
		4. Food self-reliance	4.1 Local food production 4.2 Diversified farming
		5. Water self-reliance	5.1 Water quality 5.2 Water efficient irrigation 5.3 Water efficient buildings & appliance 5.4 Water reuse
		6. Housing self-reliance	6.1 Regional materials 6.2 Efficient use of materials 6.3 Indoor environmental quality 6.4 Housing affordability
		7. Safety and security	7.1 Settlements location 7.2 Safety and security design
		8. Health & well-being	8.1 Living environmental sanitation 8.2 Community basic services 8.3 Community recreation facilities and open spaces
		9. Energy self-reliance	9.1 Embodied energy of materials 9.2 Energy efficient buildings & appliance 9.3 Local & renewable energy
		10. Economic self-reliance	10.1 Local economy improvement 10.2 Activation & empower
	Development capability	11. Sustainable landscaping	11.1 Biocapacity improvement
		12. Sustainable agriculture	12.1 Circular agriculture 12.2 Biological controls
		13. Culture & context	13.1 Protection of historical & cultural heritage 13.2 Keep local characteristics 13.3 Coordination with natural environment
		14. Inclusiveness & participation	14.1 Barrier-free facilities 14.2 Public engagement
		15. Education & information	15.1 Education space and facilities 15.2 Information facilities

FIG. 3.17 Framework of RBESAS indicators (Li and NG, 2014).

- Self-reliance capability: To meet basic human needs without over-reliance on outside resources under existing bio-capacity, and at the same time, does not reduce bio-capacity.
- Development capability: To increase the bio-capacity, and to meet human psychological needs for better development.

Li & Ng used the indicators to analyse to what level they successfully evaluate the sustainability of a rural community regarding their built environment. However, the specific contributors to housing self-reliance mention only four factors (regional materials, efficient use of materials, indoor environmental quality and housing affordability). Although the framework presents important factors which relate to housing self-reliance (waste management, safety & security, and Health & Well-being) the framework does not provide with the capacities contributing to self-reliant housing.

Therefore, inhabitant capacities have to be understood more holistically before they can be applied to self-reliant traditional housing on Mt. Elgon. The Human Capital Theory (HCT) provides with a suitable perspective to look at the overall inhabitants' capacities. Here, not only the traditional means (financial capital, labour and resources) but also the knowledge and skills of individuals are used to understand individual and community capacities (Crocker, 2006). Capacities (financial capital, labour, resources, tools, knowledge and skills) which closely relates to the inhabitants' self-reliance regarding their housing. The traditional housing offers a good example of how existing inhabitant capacities relate to a high level of independence concerning their available finances, resources, tools, building knowledge, and skills. It, however, also problematizes the difficulties they experience in articulating desired housing. Here, the required inhabitant capacities in terms of finance, resources, tools, building knowledge, and skills are not or are available. An important factor for the inhabitants of Mt. Elgon to articulate improved housing by themselves, can be explained by the lack of certain capacities.

Assessing existing inhabitant capacities and using them in housing design will sustain the level of self-reliance regarding their housing. The architect plays a vital role (Belohlavek, 2011) in assessing these capacities and to help articulate alternative housing solutions based on them. This requires a different role (of professionals) that transcends the current commercial approach, not merely offering spatial or technical solutions, but enabling inhabitants to investigate housing solutions of their own volition (Bredenoord et al., 2014). Including their available knowledge, skills and material, thereby including social structures, traditions and their self-reliance in relation to their housing.

3.4 Outcomes Research Clarification

The following section starts by concluding the RC-phase by answering the initial research questions (RQ1+RQ2) and stating the hypotheses. Secondly, stating the relevant areas for reviewing and listing these in an initial reference model. Thirdly, describing in which area the contribution of this research is expected.

3.4.1 RQ1: What are inhabitant's main contributors to self-reliant housing?

This chapter pinpointed that one of the main contributors to self-reliant housing is the communal organization. Indicating that without this regulation the spatial organization and living quality deteriorate. Furthermore, the level of inhabitants' self-reliance regarding their built environment decreases. Section 3.3, explained this phenomenon by describing this spatial organization as an intrinsic part of a CoP and the way the community sustains their building knowledge. Pinpointing inhabitant capacities within HCT as the key-factors (financial capital, labour, resources, tools, knowledge and skills) to establish general well-being. These capacities are identified as the most important contributors to inhabitant's self-reliance in relation to their housing.

Main contributors to self-reliant housing are

- 1 Housing solutions which are based on the capacities inhabitants' either have themselves or are freely shared amongst the family, friends or community members
 - a Building knowledge
 - b Skills
 - c Materials
 - d Tools
 - e Finance
- 2 Housing solutions which inhabitants are able to independently (or supported by family, friends and community members):
 - a Sustain (maintain)
 - b Extend
 - c Replicate
- 3 Inhabitants are involved in all aspects of articulating the housing solution
- 4 Inhabitants are trained to replicate the building process independently

3.4.2 **RQ2: Are inhabitants able to articulate desired self-reliant housing by themselves?**

Section 3.2, deployed mixed methods to understand the existing housing situation on Mt. Elgon. Investigating informal housing in detail on the level of everyday living activities and also how these correlates with activities of other families within the community. It became apparent that the families are able to sustain their traditional housing, however, seem to struggle in articulating improved housing. The few families which did realize improved housing had the financial means to do so or in the case of the Habitat for Humanity Project depended on financial support. Indicating that the inhabitants which did realize improved housing, increasingly depend on externally offered finances, which are paid through monthly instalments, that do not correlate with their fluctuating incomes (seasonal). Moreover, it is questionable if inhabitants have the means to maintain their house (labour, materials and tools).

As the next chapter will also show, other communities in the area are largely unable to realize improved housing. Causing the majority of inhabitants to live in traditional housing and make upgrades if and when their financial situation allows them to. Looking at the existing capacities of the majority of local families they have a high level of self-reliance regarding their traditional housing. However, current housing development on Mt. Elgon indicates that this is not the type of housing desired by the families. When looking at the existing capacities of the families they will not be able to meet the required capacities for desired housing.

Concluding, the inhabitants on Mt. Elgon are able to largely sustain traditional housing and have a high ability to sustain this housing. However, they lack the capacities to articulate desired housing and would not be able to sustain this housing when realised. Therefore, the inhabitants on Mt. Elgon are not able articulate desired self-reliant housing by themselves.

As this conclusion is based on personal observations (Introduction) and only investigated through literature review, the next chapter will investigate this phenomenon more thoroughly. The next section will address the hypotheses of this research.

3.4.3 Hypotheses

One of the products of the research clarification is the formulation of the hypotheses, which form the foundation of the following chapters. Below an overview of the research hypotheses, which in section 3.4.4 are articulated into corresponding research questions.

Hypothesis 1: Inhabitants are unable to articulate improved housing that they envisage without help.

Hypothesis 2: Inhabitants of Mt. Elgon prefer to continue building houses by themselves.

Hypothesis 3: Inhabitants of Mt. Elgon desire housing solutions that do not suit their capacities.

Hypothesis 4: Local skilled help is insufficiently able to articulate solutions based on inhabitant capacities.

Hypothesis 5: Inhabitants of Mt. Elgon lack the knowledge to articulate alternative housing without external support.

Hypothesis 6: External skilled help (architects) are unable to articulate solutions based on inhabitant capacities.

Hypothesis 7: Currently no tools exist to evaluate inhabitant capacities and use these to articulate alternative housing solutions.

Hypothesis 8: Inhabitant capacities are essential in articulating housing solutions that nurture the self-reliance inhabitants have in relation to their housing.

Initial hypotheses findings

Hypothesis 1: The introduction as well as the research clarification indicate that the inhabitants are largely (except those with sufficient financial capacities) unable to realize their desired housing. The inhabitants who have realized desired housing mainly depended on help.

Hypothesis 4: The case studies in the research clarification demonstrate that inhabitants are able to realize traditional housing by themselves. However, to realize improved housing they largely depend on help from local builders⁷, which offer comparable housing solutions consisting of mainly industrialized materials. No alternative housing solutions or materials were found in the locality of the case studies.

Hypothesis 6: The new housing development project analysed in the case study, shows that external skilled help has realized housing which the inhabitants are unable to sustain. They lack the knowledge, tools, materials and finance to maintain the housing by themselves.

3.4.4 Research Questions

Based on the previously stated hypotheses 2 and findings, the following research questions are identified for the Descriptive Study 1 phase:

TABLE 3.2 DRM-stages with corresponding Research Questions & Goals for DS1-phase

DRM Stage	Research Question(s)	Goal
Descriptive Study 1	RQ3 Which factors hindered housing improvement?	Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4 What are the necessary key-components of the design support?	Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

⁷ Local builder(s): Trained and non-trained local engineers from Mt. Elgon who conduct building/ construction activities on Mt. Elgon

3.4.5 Past Reference Model (PRM)

As stated in chapter two the DRM captures these relevant areas in an initial reference model. These areas are combined and structured according to how they constitute too traditional housing on Mt. Elgon. Which is for this purpose called a past reference model (see Figure 3.18). The key factors previously pinpointed in the research clarification are briefly explained below.

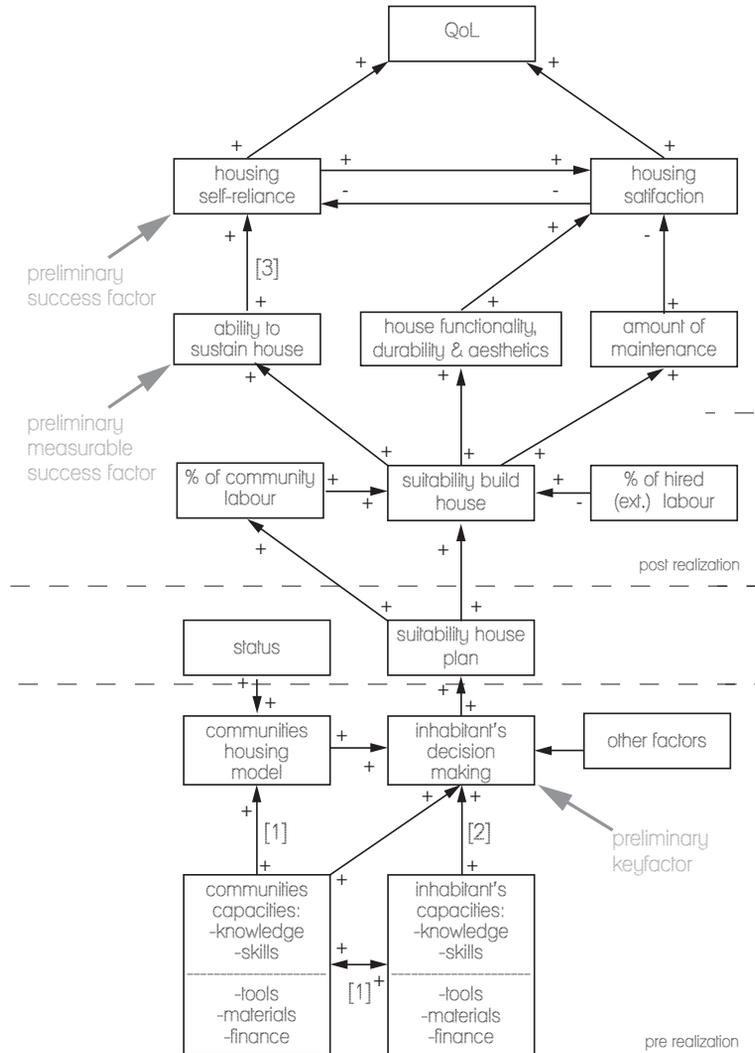


FIG. 3.18 Past Reference Model including preliminary criteria.

- [1] The Collective Intelligence regarding traditional housing on Mt. Elgon is deeply rooted in capacities the communities and its inhabitants have. Due to the frequent (shared) maintenance of the housing, the involved activities and knowledge are imbedded in everyday life.
- [2] As the capacities of the individual households were largely comparable, they shared the same image of housing model. Therefore, decisions on planning new housing only slightly differentiated according to size of the family, orientation of the plot the positions one held and minor decorations. Constituting to a suitable house plan and realization.
- [3] As an effect the inhabitants are able to maintain, extend or replicate the house (in other words sustain the house) based on their existing capacities (individual and community). Although inhabitants depend on community capacities to sustain their housing, they are largely independent from help outside the community. Therefore, these preliminary criteria are perceived are the most important contributors to self-reliant housing.

3.4.6 **Current Reference model**

As stated in chapter 2 the DRM captures these relevant areas in an initial reference model. These areas are combined and structured according to how they constitute to the situation of the current housing on Mt. Elgon. For this purpose, called a current reference model (see Figure 3.19). The key factors previously pinpointed in the research clarification are briefly explained below.

- [1] While in traditional building most capacities were shared and only labour was compensated through a lunch or small gift, now most of the community capacities are paid or rented. It's not only forcing families into an increasingly financially pressured state, but also decreases the security inhabitants used to have (they always relied on community members to help). More sophisticated knowledge, skills and tools mean a higher compensation and therefore sustain the community's housing model in becoming more commercialized.
- [2] As seen on Mt. Elgon, past externally realized projects have a tremendous influence in the decision inhabitants make regarding their built environment. Non-local building principles are preferred and make traditional building principles obsolete.

- [3] The housing project shows inhabitants are willing to accept a complete exclusion from the decision-making process. Due to a lack of involvement the external stakeholders make an interpretation of desired housing, which puts the suitability of the articulated housing to their future inhabitants at risk.
- [4] Inhabitant participation in decision-making formed an important step in the success of traditional housing. Excluding inhabitants from this process has proved in many local projects on Mt. Elgon that the solutions allowed grave programmatic and contextual mistakes.
- [5] Moreover has the community's low ability to sustain projects increased their dependency on external support (lowered their self-reliance).

3.4.7 Relevant areas to be reviewed

Another important outcome of the RC-phase is to state the areas to be reviewed in the DS1-phase and the PS1-phase. Below the overview of the relevant areas is stated.

Community & Inhabitant capacities on Mt. Elgon: this area will focus on assessing the current capacities of the Mt. Elgon communities and its inhabitants regarding their housing, as indicated in the research clarification indicates they are currently unable to articulate improved housing based on their existing capacities (without help). Through different local studies the disparity between existing and required capacities will be investigated.

Professional's capacities on Mt. Elgon: this area will focus on assessing the current abilities of the involved professionals on Mt. Elgon in relation to articulating housing solutions. As the research clarification indicates the professionals are currently unable to articulate improved housing based on the inhabitants existing capacities. Through comparative case studies the effectiveness of the current interventions is evaluated.

Existing support tools for architects to evaluate inhabitant capacities: this area will focus on analysing the currently available tools for practitioners to evaluate inhabitant capacities in relation to their housing. Describing to what extent they are able to evaluate all capacities in vulnerable contexts comparable to Mt. Elgon.

Existing support tools for professionals to incorporate inhabitant capacities in articulating housing solutions: this area will focus on analysing the current available tools for practitioners to incorporate inhabitant capacities in relation to their housing. Describing to what extent they are able to incorporate all capacities in comparable vulnerable contexts like Mt. Elgon, in the process of articulating improved and affordable housing solutions.

Existing support tools for professionals to train inhabitants in housing solution realization: this area will focus on analysing those currently available methods and tools, for professionals working in comparable vulnerable contexts like Mt. Elgon, to train inhabitants to realize improved housing. Additionally, focussing on the extend in which these methods and tools incorporate inhabitant capacities in the process of articulating affordable housing solutions.

Existing support tools for professionals to explain or convince inhabitants in housing solution realization: this area will focus on explaining why desired housing is difficult to realize based on existing capacities and therefore requires alternative housing solutions.

3.4.8 **Area in which the contribution is expected**

This research intends to close the disparity between the traditional housing and improved housing on Mt. Elgon. Here, alternative housing improvements need to be sought that meet the inhabitant's capacities and align with their desired housing perception. As stated in the RC-phase the inhabitants on Mt. Elgon are currently incapable to articulate alternative improved housing solutions, which do meet their capacities, on their volition and require the help of professionals. However, professionals involved on Mt. Elgon do not articulate solutions that meet the general capacities of the majority of the population. For this reason, the research project intends to articulate design support for architects working in remote and vulnerable communities. As there is a strong overlap between inhabitant-, material-, technological- and design analysis, the support will also be useful for engineers and designers.



4 Descriptive Study 1

In the previous chapter the problems rural inhabitants face in articulating improved housing was described. Multiple case studies indicated that similar problems occur in both rural and urban areas. However, to understand inhabitants' inability to articulate improved housing, requires a more thorough investigation. Therefore, the first part of this chapter evaluates the housing conditions of two hundred households in four different communities on Mt. Elgon. It compares the current and desired housing situation for each community, evaluating their overall capacities; it concludes by analysing their capacity gap. The findings of this part were published in the *Smart and sustainable built environment journal*¹ As elaborated in the previous chapter the practitioners lack the appropriate support tools to analyse and integrate inhabitant capacities in housing solutions. Consequently, the second part of this chapter presents the literature review assessing the criteria needed for a support tool to bridge this gap. The outcomes of this chapter help to define the necessary key components of the design support to improve the current state of the problem in practice. The outcomes of this part were published in *Frontiers for architectural research*². Based on these key-components the success criteria that influence the problem are developed, which is done by developing additional research questions for the Prescriptive Study.

¹ Smits, M. (2019). Towards self-reliant development: Capacity gap within the built environment of Mt. Elgon rural inhabitants. *Smart and Sustainable Built Environment*.

² Smits, M. W. M. (2019). Framework for capacity based sustainable design & development: towards resilient communities. *Frontiers of Architectural Research*. <https://doi.org/10.1016/j.foar.2019.07.001>

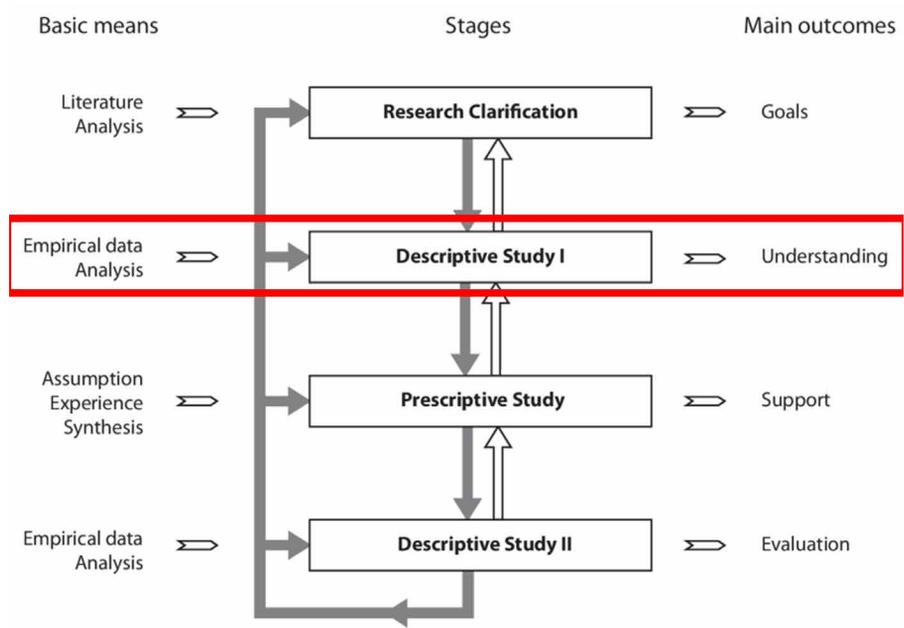


FIG. 4.1 DRM Framework (Blessing & Chakrabarti, 2009)

TABLE 4.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)		Goal
Research Clarification	RQ1	What are the main contributors to inhabitant's self-reliant housing?	Problem identification Hypotheses and Measurable Success Criteria
	RQ2	Are inhabitants able to articulate desired housing by themselves?	Addresses hypotheses 1,4,6 Answers RQ1+RQ2 Development of RQ3+RQ4
Descriptive Study 1	RQ3	Which factors hindered housing improvement?	Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4	What are the necessary key-components of the design support?	Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

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TABLE 4.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)		Goal
Prescriptive Study 1	RQ5	What helps in approaching a vulnerable context?	Goal A: Vulnerable context approach: Undesirable & desirable behaviour, appearance and communication Goal B: Vulnerable context methodology: Daily switching of actor & observer role
	RQ6	How can inhabitant capacities concerning their built environment be evaluated?	Framework for inhabitant capacity evaluation: Mixed method (interviews, observations, games & context mapping)
	RQ7	How can inhabitant capacities regarding their built environment be integrated in solution formulation?	Methodology for capacity informed decision-making.
	RQ8	How can the impact of the support be measured?	Framework for impact measurable (success) criteria: - Baseline in-depth interviews with inhabitants - Impact in-depth interview with inhabitants and community members
	RQ9	How can the suitability of the support be evaluated?	Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.
Descriptive Study 2	Test RC 1-9		Goal A: Evaluate support impact Goal B: Define the recommended adjustments to the support Verification of the Research Factors & Key-components
Conclusions			Verifications Hypotheses

4.1 Household survey

The previous section (Research Clarification) explained that Mt. Elgon inhabitants currently use materials and techniques that lay outside their knowledge sphere. If rural communities ought to continue their self-reliant housing model³, they will need a way to upgrade or improve this model (extend durability, lower maintenance, etc.) without damaging its qualities: self-building practice, climatic orientation and renewable materials. As previously investigated the evaluation and integration of inhabitant capacities are crucial to sustain the self-reliance inhabitants have regarding their housing. The observations made on Mt. Elgon indicate that the existing inhabitant capacities often contradict the capacities necessary to build their desired (or preferred) house. Inhabitants are aware of the house they would like, however, currently lack the capacities (materials, knowledge, skills and finance) to build the house. Due to the small sample size presented in the previous chapter a more elaborate investigation is required to make statements about current and desired housing. Therefore, this section investigates the conditions in which inhabitants on Mt. Elgon are living now and how they would prefer to live in the future (desired housing). Moreover, it investigates if inhabitants would like to learn how to build improved housing by themselves and evaluate their willingness to help each other in realizing improved housing. Furthermore, it identifies fundamental thresholds which limits the options for inhabitants to realize improved housing (for example landownership).

As previously stated, the rural area of Mt. Elgon proves a representative study area⁴ in which communities with various levels of capacities can be found. This section explores the inhabitant's general capacities and identifies what shortages are preventing them from improving their houses. For this purpose, over two hundred families participated in a survey conducted in February 2017. Due to the sensitive context of the survey a questionnaire (controlled questions) was combined within an interview (room for questions by the interviewee) performed by local trained researchers. The researchers were academically certified (master's degrees in social studies), aware of local customs and easily adjusted to difficulties during the interviews. The interviewer had the opportunity to answer questions and explain the

³ Self-reliant housing model: housing model which meet the current and future capacities of its inhabitants, enabling them to maintain, extend or replicate the housing without support.

⁴ Representative study area: the level of 'development' in the area is representative for many others.

interviewee's privacy rights (informed consent). To have a representative sample of the Mt. Elgon area, four communities with different levels of income, housing and ownership were targeted. Per community (around 50% of the entire population) were targeted of approximately 100-120 households to also have a representative sample of each community. Moreover, one male and one female researcher investigate every community, sampling 25 females and 25 males all from different households.

This section will focus on the type of house most of the rural inhabitants of Mt. Elgon live in at the moment (wattle and daub-based) and compare to the one they desire (industrialized). This will help expose and analyse the disparity between existing inhabitant capacities and those required to articulate desired housing. This section will explore the study executed on Mt. Elgon in three steps. Firstly, explaining the context of Mt. Elgon and relevance of the targeted communities. Secondly, describing the methodology and consecutive execution of the study in February 2017. Thirdly, elaborating on the most important outcomes of the study, stating the elements that hinder success and the identified key elements for possible support. This section will prove that the communities on Mt. Elgon have a shared notion of their desired house. This shared image is studied in detail, including: size and materialization. However, proving that more than half of all the participants of the presented study estimate that they won't be able to afford the desired house. Resulting in a large part of the population remaining in challenging conditions. Moreover, do 75% of the studied communities live in wattle and daub-based houses. Indicating a need for alternative solution(s) for a large part of the community.

On Mt. Elgon four communities were sought to analyse their current and desired housing. Considering the available resources for this study, a total of 200 inhabitants were interviewed. Based on this scope several criteria were chosen to identify the communities: firstly, to have a substantial, representative sample, at least 40-50% of each population had to be included in the study. Therefore, four communities of around 100-120 families were sought in Mt. Elgon area. Secondly, to prevent a subjective representation, communities with variable levels of income were selected (only selecting poor communities would support the claim that capacities do not meet the desired housing). The communities on the North-eastern slope of Mt. Elgon have varied levels of income (areal employers include: Mt. Elgon Orchards, ADC Japata and ADC Suam) good schooling and healthcare. Thirdly, a mixture of housing quality had to be identified. It was crucial to show that the mismatch between capacities and desired housing are present amongst different levels of income and quality of housing.

Four researchers from Nairobi University and a local social worker deliberated with village elder and areal chief for suitable communities in the Northeast area of Mount Elgon. Here, twelve rural communities were evaluated according to previously

mentioned criteria. The considered communities were (in brackets the estimated inhabitants): Chepchoina (70), Cherubai (200), Habitat (94), Japata (90), Kaisheber (150), Kaptega (50), Koronga (550), Nabeki (420), Njoro (300), Sokomoko (100), Famia (150) and Wangu (30). Finally four communities in proximity to each other were selected and grouped:

- No/low income, do not own plot, mainly renting/self-built houses
- Low/regular income, do not own plot, mainly/self-built renting houses
- Low/regular income, inhabitants do own plot, mainly self-built houses
- Regular/high income, inhabitants do own plot, mainly commercially built house.



FIG. 4.2 Map of the selected communities on Mt. Elgon

The Japata settlement near Kaptega river was selected as group 1 (Figure 4.2: red marker). This community of approximately 70 households, was allowed to temporarily settle themselves as farm workers and since independence (1963) have been living there. They do not own the plot they live on, are not allowed to build permanently, and have low/non-existent incomes.

Chepchoina village was selected as group 2 (Figure 4.2: green marker). This community of approximately 110 households lives around the Chepchoina village market. The plot is not owned by the inhabitant; most of its residents rent a house in this area. The families have a mixed income and often combine small business with farming, generating a low/regular income. This community has its own marketplace and bus stop, which influences landownership.

Famia was selected as the group 3 (Figure 4.2: blue marker) consisting of approximately 120 households. The plot belongs to the inhabitants and they mainly have a regular income combining a commercial position with farming their lands.

The Habitat community was selected as group 4 (Figure 4.2: orange marker). Consisting of 94 households owning their plots. The majority works fulltime for a commercial farm and have a regular/high income.

Outcomes of the survey show that the majority of the respondents used natural materials to build their current housing. Moreover, that these materials were collected locally and for free. The only involved costs would consider transportation.

Survey, mixed methodology: interview & questionnaire

Studying inhabitant capacities in relation to their housing, involves both quantitative and qualitative aspects. Quantitative capacities consider measurable aspects such as: income, size of family, ages, etc., where qualitative capacities consider why and how they live at the moment. Moreover, it allowed to understand their housing preferences. For this purpose a mixed method was used, where both questionnaire and structured interview are performed in a survey framework (Creswell, 2013). The questionnaire was used to register quantifiable answers, closed questions and later on to compare the 200 outcomes. The structured interview was used to address open questions and help to understand the motives. A structured interview is chosen to ensure that the interviews follow the exact same procedure. The questionnaire supports the structured interview to ask the same questions in the same order amongst all 200 participants of the survey.

Interview context

The survey was performed in a vulnerable environment where many of the participants have difficulties to sustain a living (below international poverty line: \$1.90 p.p.p.d.). Moreover, many participants live in a traditional house and conservative relation between man and woman. Therefore, it was essential to take preliminary precautions. As the community elder, chief and a local social worker were already involved, they were also aware of the survey and informed the communities. To get a balanced perspective all households, 100 surveys were conducted with women and 100 surveys with men. To prevent social/cultural dilemmas two female and two male researchers were hired (see Figure 4.3). The head of a local organization, Sophie E. Kibuywa (Desece: development education services for community empowerment) and has decades of experiences in conducting local researches. She recruited the researchers and instructed them for the survey. Pauline Nabalayo was appointed as team leader (most experienced).



FIG. 4.3 (left-right): B. Sawenja, K. Hamphrey, S. Kibuywa, P. Nabalayo and A. Nyangugu (author: M. Smits)

During the survey the researchers were staying separately (men/women) in the middle of the targeted communities. Two communities were next to their place of residence and two communities were in a short travelling distance (max. 5 minutes on motorbike). There was an office space arranged at the local hospital.

Interview instruction & guide

To prevent as many inconsistencies as possible in executing the surveys, a questionnaire instruction sheet was prepared for the researchers (see Appendix A). The instruction explains step by step how the survey has to be performed and what the points of attention are. Starting with the research introduction, in which the survey is positioned, gives the objective and aim; continues by introducing the composition (targeted age and such) and explains the practicalities of the questionnaire: location, recruitment of the participants, picture/audio recording, venue, breaks and ethical issues. Ensuring that: the surveys were taken in a safe environment, with the participants of appropriate age and gender and not invading the participant's privacy. The interview guide has a similar purpose to the instruction. However, it gives the exact questions that need to be addressed during the interview. The guide (see Appendix B) was written according to the advised structure of an interview guide by: Qualitative Research Methods (Hennink et al., 2010). Starting with the research purpose and explains the attached consent procedure (see Appendix B, p.7). The researchers are asked to read the consent form and answer any questions of the participant. When the participant's questions are answered the interview can be conducted. The questions are divided in three sections: general information, questions about current house and questions about the desired house.

Section 1: The general information questions are closed quantitative questions which are relatively easy and comfortable to answer. Questions are meant to evaluate family size, occupations, ages, financial capacities and landownership. The answers will help understanding the extent to which these capacities enabled the current and desired type of housing.

Section 2: The questions on current habitation aim to understand the existing house housing conditions. The questions emphasize ownership, amount of structures, house size, in/outdoor functions, used materials, self-building practise, help from the community members, satisfaction, maintenance and the reasons for not realising the desired housing.

Section 3: Questions in this section focus on the participants' desired housing. The closing questions in this section emphasize if they would be able to afford⁵ the desired house based on their existing capacities. Moreover, if they would prefer to build the house by themselves, helped by their community.

The questionnaire was made available via GoogleSheet, accessible by smartphone (all researchers had one). As backup all interviewers had a printed version of the questionnaire, interview guide and instruction with them.

Pilot & Adjustments

On the 30th of January 2017 the first pilot was run amongst the researchers. They were requested to test the survey (using the printed English questionnaire, making audio recording and pictures) on each other. The team concluded that there was a necessity of translating the questionnaire to Swahili as it was too difficult to do this simultaneously during the interview. The cross-cultural survey guidelines of Mohler et al. (2010) provided with an appropriate team translation model that suited the requirements of this study. Also called The Team Translation Model Procedures (TRAPD). The group researchers were divided in two teams and separately made their translation. In the review session they compared their translations, discussed the differences and made a concept translation. The results were reviewed by the team leader (Sophie E. Kibuywa) and returned to the team. They had a second adjustment session when they debated the review and made a final translation (see Appendix C).

⁵ Afford: to what extend the capacities enable or disable a realization.

Executing the survey

The survey started with one research team in the Japata ADC and one in the Habitat community. Every time locating one household that had a mother present and another that had a father present. According to the set target every team conducted between 8-10 interviews per day. The researchers used the physical print to write down the answers of the participants and their phones to make the audio recordings. After each survey the researchers took a picture of the participants (see Figure 4.4).



FIG. 4.4 (top to bottom): Samples of the Japata ADC & Habitat community (author: M. Smits)

Afterwards they were given one kilogram of sugar per household as compensation for the time spent on the interview. At the end of the week the researchers used three days to digitalize the 100 answer sheets and upload the pictures and audio recordings.

On February 16th the survey continued in the Famia and Chepchoina communities, following the same procedures as the Japata ADC and Habitat community (see Figure 4.4). The research teams were able to finish the second round of 100 surveys by February 24th.



FIG. 4.5 (top to bottom): Samples of the Famia & the Chepchoina community (author: M. Smits)

Outcomes survey

In the following sections the outcomes of the survey are compared between the four communities. In each consecutive part of the questionnaire the most important findings are explained. The dataset of the survey can be found in Appendix D.

General information questions

TABLE 4.2 Shared income, Income stability & Family size

5. How much is your shared income?				
	Japata	Chepchoina	Famia	Habitat
<1000	0,0%	4,7%	5,9%	0,0%
1000 to 2499	9,1%	4,7%	2,9%	2,0%
2 500 to 4 999	20,5%	9,3%	17,6%	3,9%
5 000 to 7499	40,9%	16,3%	17,6%	2,0%
7 500 to 9 999	13,6%	16,3%	5,9%	21,6%
10 000 to 2 4999	15,9%	37,2%	32,4%	60,8%
25 000 to 49 999	0,0%	9,3%	5,9%	7,8%
50 000 to 99 999	0,0%	2,3%	0,0%	0,0%
100 000 to 500 000	0,0%	0,0%	11,8%	2,0%
6. Is this stable, or does fluctuate seasonally or occasionally?				
	Japata	Chepchoina	Famia	Habitat
stable	18,4%	28,9%	19,5%	64,2%
fluctuates	81,6%	71,1%	80,5%	35,8%
8. Amount of children				
	Japata	Chepchoina	Famia	Habitat
from 0 to 3	42,9%	69,4%	36,6%	32,1%
from 4 to 7	38,8%	22,4%	43,9%	58,5%
from 8 to 11	18,4%	8,2%	17,1%	3,8%
12 and more	0,0%	0,0%	2,4%	5,7%

Table 4.2 projects shared income of the household, income stability and the family size, between the communities. Although the Habitat and Chepchoina community have a higher average income, the majority of inhabitants (>50%) earn up to 25000 KSh (roughly \$250) per month. Considering that most families of the community has between 0-7 children this leaves the households with \$4 per person per day (2-person household), \$1,6 in a five-person household and worst-case \$0,8 in a nine-person household. With income fluctuating seasonally in at least 70% of the

households in three out of four communities, questions arise if the families are able to sustain basic life necessities (as they are far under the international poverty line: \$1,90). It is important to state that Japata has a considerably lower average income.

TABLE 4.3 Questions on: Farmland, Ownership and the contribution to livelihood.

12. Do you have a farmland (shamba)?				
	Japata	Chepchoina	Famia	Habitat
Yes	38,8%	54,2%	80,5%	94,3%
No	61,2%	45,8%	19,5%	5,7%
13. Do you own this farmland?				
	Japata	Chepchoina	Famia	Habitat
Yes	0,0%	34,7%	70,7%	84,9%
No: company land	79,6%	0,0%	0,0%	1,9%
Unknown	20,4%	22,4%	17,1%	1,9%
Family land	0,0%	12,2%	9,8%	7,5%
No	0,0%	24,5%	0,0%	3,8%
Rented	0,0%	6,1%	2,4%	0,0%
14. Does it generate income?				
	Japata	Chepchoina	Famia	Habitat
Yes: Grow crops for family	36,7%	28,6%	63,4%	66,0%
Yes: Grow crops for family and Selling	2,0%	18,4%	14,6%	18,9%
Unknown	59,2%	22,4%	22,0%	1,9%
No	2,0%	30,6%	0,0%	13,2%

Table 4.3 shows that although most households state that they are not farmers (<15%) three out of four communities has a majority that has a farmland (>50%), which contributes to their daily livelihood. Current capacities in the communities show that some of the households have been able to secure a stable and substantial income. However, the vast majority of the households have a daily budget below the poverty line and does the income fluctuates often in most cases. It makes the households highly vulnerable and indicates that making ends meet is difficult. Therefore, the financial capacities for materials and labour in providing housing are marginal. The next section will investigate in more detail how these capacities relate to current habitation.

Questions on current housing

Ownership in the communities differentiates substantially (see Figure 4.6). The majority of households in the Famia and the Habitat Project own both the house and the plot, where in, Japata and Chepchoina there are considerably lower levels of ownership. The government owns the land on which the Japata community lives and are most inhabitants' workers of the Japata ADC farm. Japata has an almost equal ownership and renting division. However, as they do not own the land it is questionable to what extent this is permanent. Chepchoina has almost solely renting residents (>95%) and therefore the majority has no land rights. The opposite is happening in neighbouring Famia. Here, the majority (>70%) owns both land and house. Despite the differences in all three mentioned communities, the vast majority (>90%) of their households live in wattle and daub-based houses. This occurs despite the fact that Chepchoina and Famia on average have a much higher income than Japata. Even renting does not seem to enable households with an average higher income to live in an 'improved house'. Which can be explained by two factors: availability of brick houses and fluctuations in income. The latter explained by the 70-80% of households in these communities have seasonal jobs. The Habitat community stands quite the contrary to the other three communities. Here, the land is individually owned, however, can only be sold back to the community. Meaning, that the house including the plot can only be sold to someone who is approved by the entire community. Considering the height and the stability of the income of this community (working for Mt. Elgon Orchards ltd) they are the most financially capable in affording an improved (brick) house.

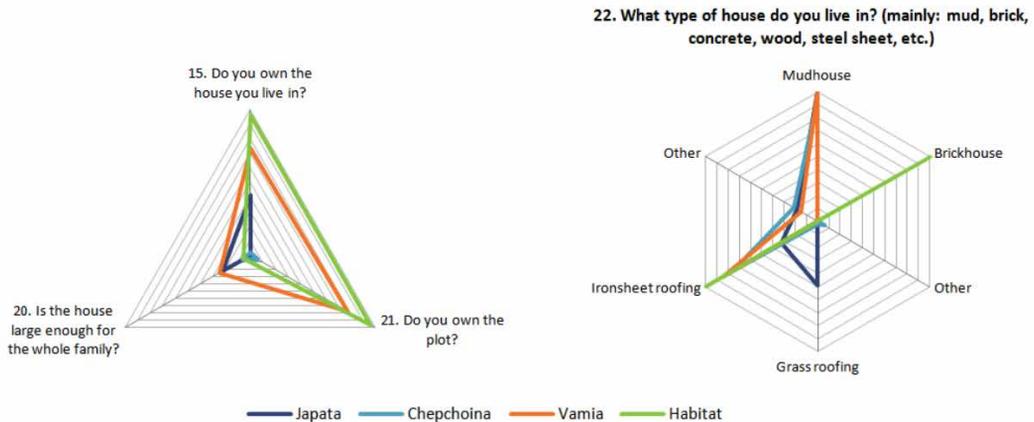


FIG. 4.6 Left: House ownership, Land ownership & Size suitability; right: Type of current house.

However, it seems that in none of the communities their current capacities have amounted sufficient living space for the whole family (Figure 4.7). With the majority of the households having between 0-7 children living in a house of between 5,7 to 13,7 square meters this problem can be explained

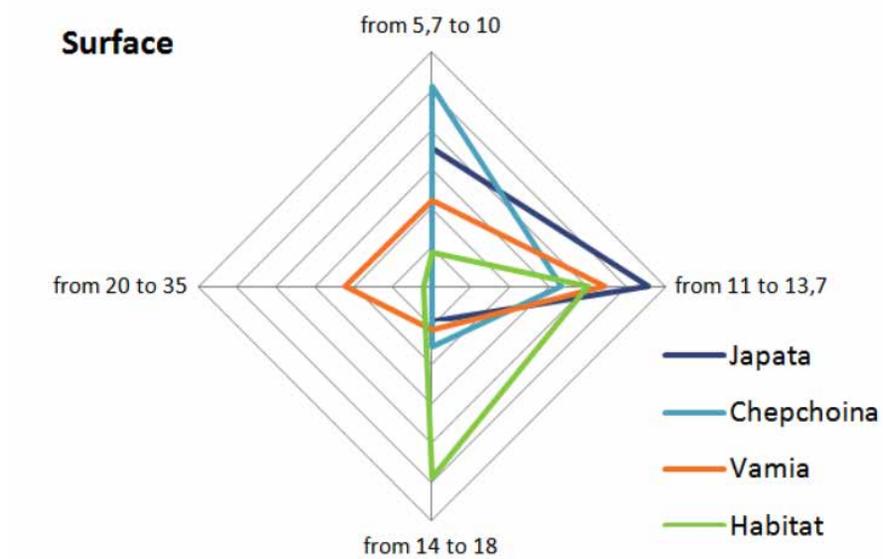


FIG. 4.7 Surface of current house

In the case of Japata and Famia the majority of the building materials (75-100%) are not bought but collected. The only costs involved are to cover transportation. Table 4.4 shows the large amount of natural materials used in constructing houses, which makes them affordable, especially amongst the communities with a low income.

TABLE 4.4 Material cost & availability

If yes: a. Did you have to pay for the materials or are there other ways of collecting/ acquire these materials				
	Japata	Chepchoina	Famia	Habitat
Pay	14,8%	0,0%	0,0%	100,0%
Free	7,4%	14,3%	0,0%	0,0%
Collected	14,8%	4,8%	0,0%	0,0%
Collected and paid for transportation	63,0%	19,0%	100,0%	0,0%
N/A	0,0%	61,9%	0,0%	0,0%
25. Are those materials local natural resources (e.g. mud or straw) or Manufactured (e.g. cement, iron sheet)?				
	Japata	Chepchoina	Famia	Habitat
Natural	100,0%	78,3%	90,0%	0,0%
Industrial	0,0%	21,7%	10,0%	0,0%
Both	0,0%	0,0%	0,0%	100,0%

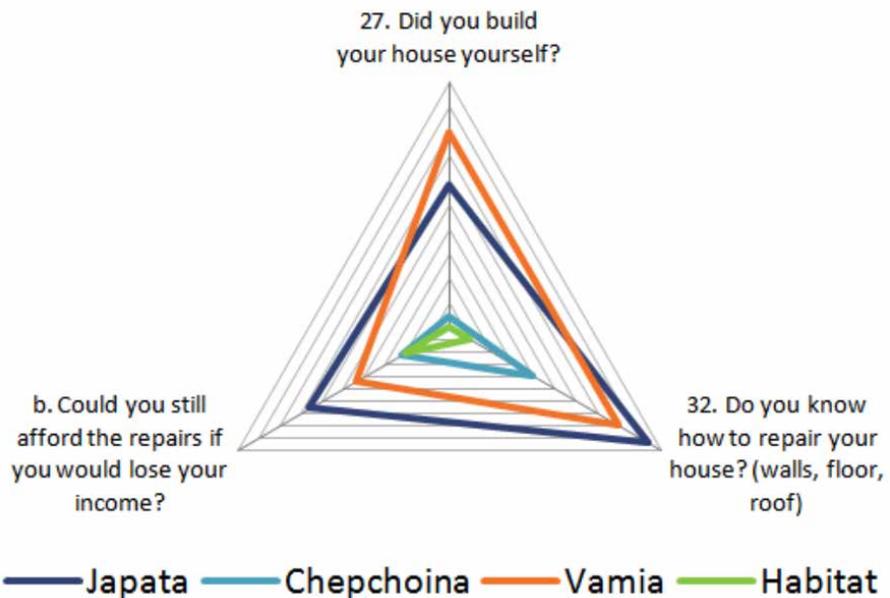


FIG. 4.8 Self-building practice, repair ability and affordance

Looking at the self-built practice (Figure 4.8) especially in Japata and Famia this correlates with the maintainability of the house. The opposite happens in the Habitat community where more than 90% is not able to maintain the house by themselves.

A more worrying trend seems to be the ability to afford maintenance in case income becomes low or stops altogether. The Japata community actually has the most positive score in this section. Here, over 65% of the households think they will be able to pay for the maintenance on the house, due to the availability of materials.

Although the capacities and living situations differ strongly, they all seem to result in an opinion of dissatisfaction on the house (Figure 4.9). The Habitat community shows a little more content with the existing house, however, >80% still prefers to build the house differently. In the habitat community this is often connected to the size of the house. Where for Famia this is more connected to the used materials for the house. For the Japata and Chepchoina this is connected to ownership and used materials. When asked why, the majority answered: due to the lack of funds, which most likely is linked to the type of materials they would have preferred to build with (>80%). Moreover, when asked if they would know how to build this house by themselves, more than 64% of all respondents do not think they are able to do so.

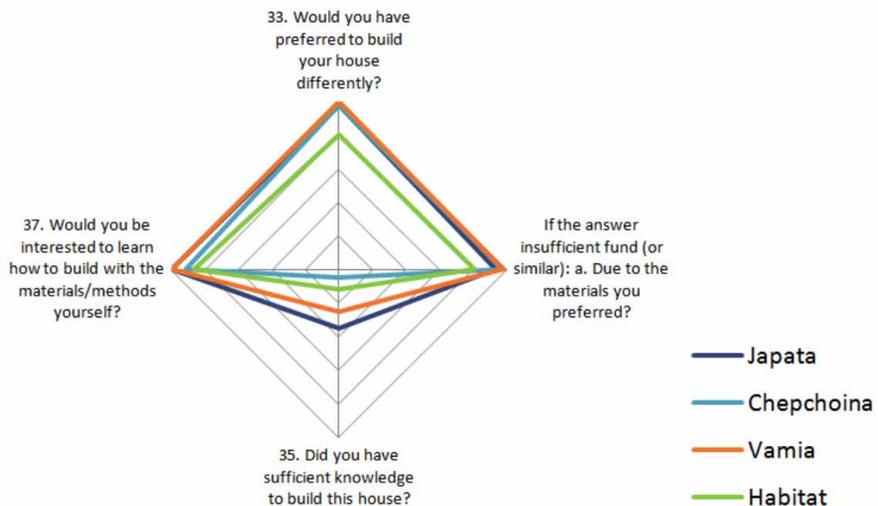


FIG. 4.9 House preference, sufficiency funds, building knowledge and willingness to build by oneself

The last question on the existing house inquires if the inhabitants would be interested to learn how to build their desired house. What they most likely do not consider is the knowledge, skill level and training needed to build such a house. Building such a house would require extensive professional knowledge, skills and training, such as: mason, steelworker, carpenter, etc. Those types of trainings

would either take many years in training or learned on the job. Indicating not only a problem in comprehending the needed requirements but also that there is a considerable knowledge, skill and training gap between the currently used and desired building technique. In the last section on the results this topic will be further explored

Questions about Roofing sheets



FIG. 4.10 (left to right): roofing sheet Chepchoina, thatched roof Famia (author: M. Smits)

In section 1.2 explained that houses built with thatch in comparison to roofing sheets, seem to be cooler during the day and warmer during the evening (see: Figure 4.10). When it rains the roofing sheets produce a lot of noise in comparison to the thatched roof. To better understand if the inhabitants had similar observations and how they reflected on material suitability, a short section was included in the survey. Figure 4.11 shows the results on the existing house (left image). With the majority of the communities having roofing sheets (Japata >32%, Chepchoina, Famia & Habitat 75-100%) they have sufficient experience to reflect on the effects of the roofing sheet.

Results show that the majority of the households find the roofing sheet radiating heat when the sun is shining (>90%) and makes noise during rains (50-95%), confirming the initial observation made in the communities. Despite these disadvantages the majority still uses roofing sheets. Moreover, the majority does not know any cheaper alternatives (50-90%). The rest of the respondents do point out thatched roof as existing alternative. Respondents admit that those alternatives would react better to sun (50-90%) and rain (80-100%), indicating that there are no cheaper alternatives, however, they have better characteristics than roofing sheets. Which indicates a possible knowledge gap of alternative roofing solutions within the communities.

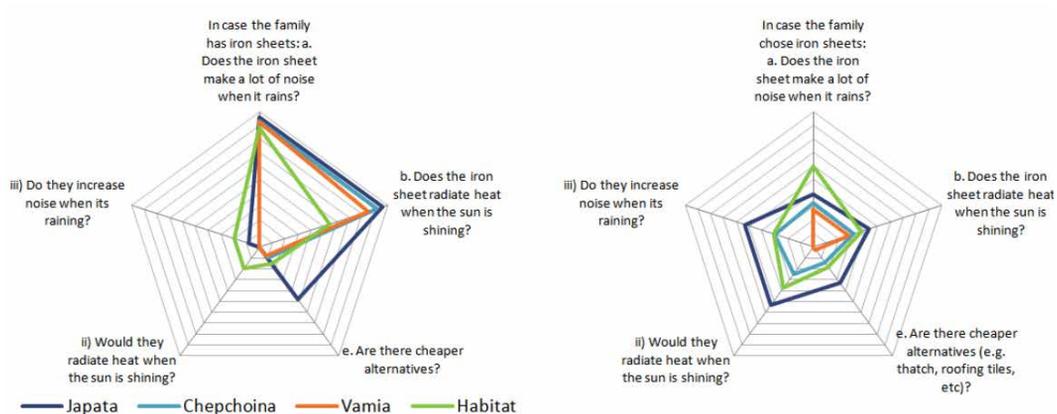


FIG. 4.11 Left: Opinion about existing roofing sheet; Right: Opinion about desired roofing sheet

The same questions were asked after households stated their preferred type of house. Here, between 70-90% of the households (Figure 4.11, right image) answered that they prefer using iron sheet roofing. When asked if the iron sheets made noise during rain or radiate heat when the sun is shining, the answers were quite the opposite to their current housing. Here, the majority of the households (rain noise: 40-70% & sun radiation: 55-70%) stated that the iron sheets do not have this effect. In the interviews many households stated as main reason, that there are no cheaper alternative as it is difficult to find grass locally. Due to this shortage people started to sell grass as a building product. The available 'free' grass must come from such a distance that the transport costs are almost equal to buying roofing sheets. Moreover, in their opinion the grass roofing requires more maintenance, leaks more often and is a potential fire hazard. Other reasons for preferring roofing sheets, are: fire resistance and insect-proof. It seems that these reasons influence their perception on the disadvantages of the roofing sheet.

Questions on desired house

The questions in the third section of the questionnaire focused on desired housing. In the Japata and Chepchoina community respondents would all prefer to own both the house and plot. Among the other communities 95%-100% of the households would prefer to own their house and the land they live on (Table 4).

TABLE 4.5 Desired house/land ownership.

39. Would you prefer to own or to rent the house?				
	Japata	Chepchoina	Famia	Habitat
Own	98,0%	100,0%	100,0%	100,0%
Rent	2,0%	0,0%	0,0%	0,0%
44. Would you prefer to own a plot or rent a plot?				
	Japata	Chepchoina	Famia	Habitat
own	100,0%	97,9%	100,0%	100,0%
rent	0,0%	2,1%	0,0%	0,0%

When asked which materials they would prefer to build their desired house from (see Figure 4.12) the majority chose bricks (45%-75%) and iron sheets (70%-95%). Most households state that the preferred materials are expensive (see Table 5).

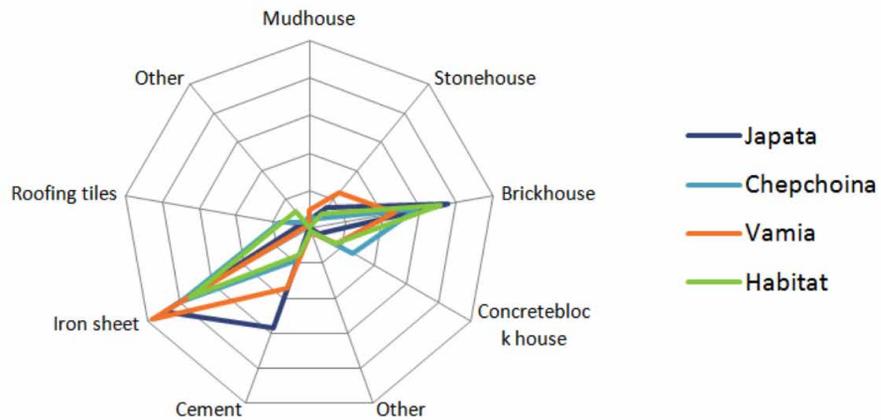


FIG. 4.12 Preferred materials, material costs

TABLE 4.6 Material costs

47. Are those materials expensive or cheap?				
	Japata	Chepchoina	Famia	Habitat
Expensive	81,6%	63,0%	87,8%	56,6%
Cheap	18,4%	37,0%	12,2%	43,4%

Figure 4.13 shows that they prefer to build the house by themselves (75%-95%) and if they can't or won't build the house by themselves, they will need to hire labour (90%-100%). Japata and Famia think that their community would help most of them in building the house (>95%), which in Chepchoina (mainly renting) and Habitat (formed community) is quite the contrary. Argueing that these communities are differently organised and therefore inhabitants are reluctant to help each other. This, in the Habitat community is strange considering the fact that they own the land communally. What is most worrying, is that three out of four communities will not be able to make house repairs when they lose their income.

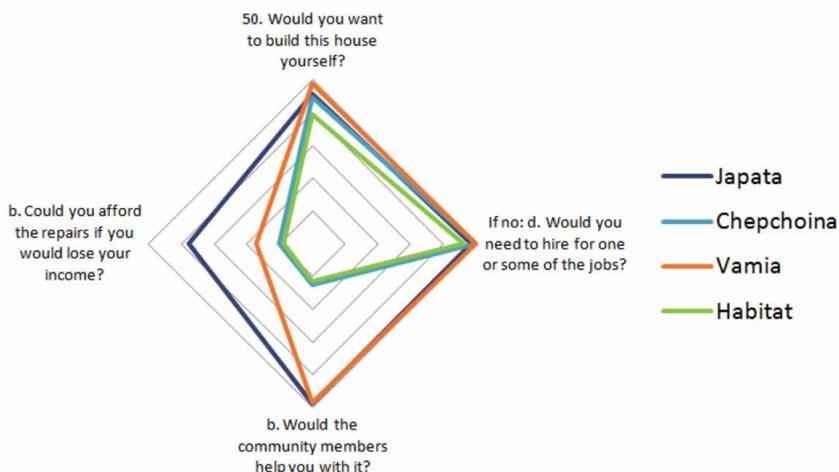


FIG. 4.13 Self-build preference, community help and affordance

The willingness to learn how to build the desired house is very strong (Figure 4.14) amongst all households: 95%-100%. Indicating that self-building practice is preferred. Although in some communities there are doubts if community members would be willing to help others to build a new house.

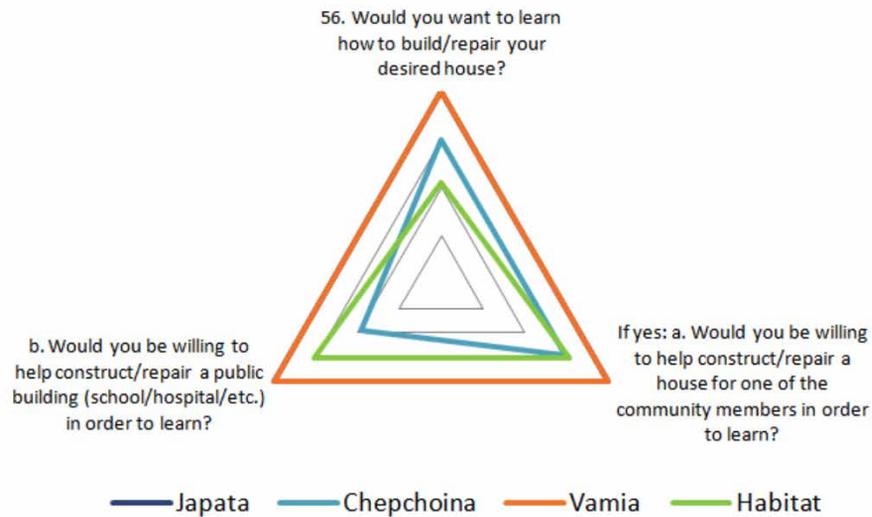


FIG. 4.14 Repair preference house, help of community members and willingness build community infrastructure

However, almost all households are willing to help (95%-100%) a community member if they can learn how to build in return, indicating there is a strong willingness to learn by helping each other (see: Figure 4.14). What might be even more interesting is that again the vast majority of the households are willing to help construct public buildings to learn how to build in an 'improved' way.

4.1.1 Goal 1: Problem expressed in practice (inhabitants)

The outcomes prove that the majority of the interviewed households are living in challenging living conditions, in most cases in wattle and daub-based houses, often too small for the entire family. Although the households living in these conditions which housing, they require, they lack the capacities to realize their it. The lack of landownership is for the Japata and Chepchoina community an important obstruction for realizing improved housing. These communities are not allowed to erect any structure without approval of the owner. In the case they are, they do not own the structure, and if the owner revokes their land rights, they will have to leave immediately. The Japata community lives on government land and is not allowed to build any improved housing. The Chepchoina community mainly rents (land and house) and is very vulnerable to changes in income. The Habitat community has severely restricted land rights and is not allowed to make any extensions/additions.

The Famia community has the most households owning their land and house. With an acceptable and stable income, it is unclear why they were not able to build desired housing.

The survey confirms that the inhabitants are largely unable to realize improved housing and require assistance to articulate improved housing according to their current capacities. Thus, confirming that the problem is expressed in practice.

4.1.2 **RQ3: Which factors hindered housing improvement (inhabitant)?**

The majority of the interviewed households have more than sufficient capacities to build a house by themselves. This 'traditional' way of building is a shared practice within the family and the community. This practice suits most of their capacities, for example materials are locally available and are often free or exchanged. Materials are gathered over a longer period and are estimated based on the size of house required for the family to live in. Inhabitants only require few tools and the ones they do not have are easily borrowed from community member. The required knowledge and skills are passed by every generation and therefore are freely available. However, almost all households desire a different type of housing. Looking at what those preferences would require, there is a mismatch between what inhabitants currently have and what they desire. The lack of locally available alternatives in typology, material and building methodology, limit the scope in which the households consider alternative options. Inconsistencies in the interviews point out that inhabitants not always prioritise according to the material characteristics but to their appearance (as seen by the contradictions in the answers on iron sheet roofing).

Moreover, are possible alternatives difficult to articulate without a substantial knowledge base. This makes the formulation of a possible alternative 'desired' house by the inhabitants themselves difficult. Integrating their current capacities into alternative solutions will play a vital role to its success and implementation. As shown in this study, considering alternative solutions that do not meet the inhabitants' capacities is simply not viable (no mortgage loans available). The study proves that there is a high willingness to build by oneself, help each other and help to build public buildings. This sense of community is fundamental in advising rural communities how they can improve their living environment without losing their self-reliance.

Concluding, the main factors that hinders the realization of improved housing by the inhabitants are:

- Inhabitants do not want to continue traditional housing solutions that meet their existing capacities.
- Inhabitants lack the (mainly financial) capacities to afford desired housing
- Inhabitants lack the knowledge of the alternative solutions that meet both their desired housing as their existing capacities.

4.1.3 Hypotheses 2,3,5&8

In reflection to the survey outcomes the following hypotheses can be confirmed:

Hypothesis 2: The respondents confirm that they prefer to continue building houses by themselves and have a high willingness to learn through realizing other people's housing or public buildings.

Hypothesis 3: The respondents acknowledged that their preferred materials for desired housing are mainly non-local and manufactured. Moreover, that they require hired labour to realize desired housing.

Hypothesis 5: Although none of the survey questions addressed the specific need for external support (from outside community), the majority did confirm that they require assistance in articulating improved housing.

Hypothesis 8: The outcomes of the survey point regarding a disparity between the existing inhabitant capacities and those necessary for articulating desired housing. This causes a threshold to articulate improved housing and requires the articulation of alternative housing solutions that do meet the inhabitant's capacities.

4.2 State of the Art & Necessary key-components for the design support

The research clarification addressed the importance of inhabitant capacity evaluation for self-reliant housing and was confirmed in the previous section. Inhabitant capacity comprehension and integration in housing solutions requires high engineering and design skills. It requires a complicated comparison between a multitude of factors: social, cultural, financial, material, spatial, environmental and climatological. A task which seems most appropriate for architects. As explained in the first chapter of this research, practitioners involved in project development on Mt. Elgon had limited experience working in the locality and their training (education) insufficiently prepared them to work in vulnerable environments. Most importantly, they lack ability to analyse and integrate existing inhabitant capacities (as previously described in RQ3) into suitable housing solutions. Adjusting the education of the practitioners involved on Mt. Elgon to meet these requirements is admirable goal, however, is not viable. For this reason, the literature review in this next section will address past and current support tools related to realizing housing in comparable contexts. The tools are divided in two categories: support tools and general support. The latter are tools which address improved housing in general, not offering practical manuals or tools, but merely focussing on policies or training on an organizational level.

4.2.1 General support and support tools before 2000

Support Tools, Habitat for Humanity 1: A large portion of all the support tools, toolkits and manuals developed for people operating in the context of vulnerable housing development was written by the United Nations Centre for Human Settlements (Habitat). Starting at the mid-seventies till the late 90s, a wide variety of practical manuals were developed to support local operating engineers in implementing alternative construction technologies (Raghavan, 2001). Many publications focussed on alternative materialization with earth and the required equipment (UN-Habitat, 1975, 1986, 1987a, 1987b), describing the practical implication of applying those solutions in a development context. It, however, does not support the engineer to weigh the suitability of this solution against the inhabitant's capacities. Nor does it assess the involved local stakeholders' ability to reproduce the applied solution without help.

General Support, Habitat for Humanity 2: This problem can however be solved by using one of the many manuals developed to provide trainings in alternative construction technology (UN-Habitat, 1991a, 1997b). However, these trainings emphasized on the role of municipal agencies (UN-Habitat, 1991b) and provided tools to execute trainings on a national level. Involving government and province stakeholders in providing improved shelter solutions (Fisher, Tees, & UN-Habitat, 1994b; UN-Habitat, 1988, 1991a, 1997b). Therefore, not effectively involving inhabitants in adopting and applying offered knowledge locally. As also seen on Mt. Elgon these resources often do not reach the remote communities they were intended for.

General Support, Habitat for Humanity 3: In the same period UN-Habitat established a network of African countries to share policies, approaches, frameworks and manuals in the field of local building materials and technologies (UN-Habitat, 1989). The results were shared via the *Journal of the Network of African Countries* on local building materials and technologies. Most of the issues aimed at identifying alternatives for portland-cement building products (UN-Habitat, 1989, 1993, 1994, 1995), although the majority introduced other industrialised products, there was an overall criticism that most of the were imported materials to supply the local market in Africa (UN-Habitat, 1990). Comparable to the previous paragraph, the journal issues aimed at offering solutions on a 'governmental level', specifically on energy reduction strategies (UN-Habitat, 1995) or health risks (UN-Habitat, 1996b).

Support Tools, Habitat for Humanity 4: Leading up to the HABITAT II conference (1996) it became clear that NGOs were becoming important stakeholders to offer housing solutions to inhabitants (UN-Habitat, 1996a). NGOs started to gather their own knowledge and experience, developing them into support tools. From 1988 Habitat started to publish these results in an effort to make an overview of the best practices within one catalogue (UN-Habitat, 1988). Providing training programmes (Wynn, 1986), evaluation frameworks for developed projects (Rugh, 1987), courses for architecture students to engage in real-life impoverished communities (Ast, 1979, 1982), an elaborate overview of activities for community involvement (P. Ellis, 1983), small scale material production (Smith, 1986; Spiropoulos & German Appropriate Technology Exchange., 1985; Webb, 1986), alternative housing solutions (Ministerio da Agricultura, n.d.) and practical step by step manuals to train or advise inhabitants on alternative building solutions (Batchelder, 1985; Grupo Talpuy, 1984; Mills, 1981; Minke, 1977; Nisnovich, 1986). Although the combined publications form an interesting and useful body of knowledge, they do not provide with one directly applicable support tool to help NGOs, engineers and architects working in vulnerable communities to articulate improved housing, based on inhabitant capacities.

Support tool, Peace Corps 1: Even though UN-Habitat was by far the largest international organization articulating shelter development support around the world, there are other large organization which published equally important and useful manuals. For example the Peace Corps, which released an extensive manual for development in remote areas (Peace Corps, 1964). Explaining theories on social anthropology and development, best practices on agronomy, horticulture and closing with a large section on self-help engineering and housing (although brief). In their homemaking handbook, they help volunteers in practical tools to evaluate and stimulate livelihood conditions in relation to home development (Peace Corps, 1971). However, the tool presents known 'traditional' building solutions and insufficiently reflect contemporary capacities and needs.

Support tools, Miscellaneous: Afterwards, more practical engineering manuals were developed for self-help construction (Gallant, 1977), how to make tools (Christiansen & Bernard Zubrowski, 1981), building homes of earth (Peace Corps, 1981) and bamboo (McClure, 1982). Equally to UN-Habitat the Peace Corps also developed some manuals on managing projects (Wzorek, 1987) and toolkits for building capacity (Peace Corps, 2002). However, in comparison to UN-Habitat, the majority of the developed tools are meant for volunteers operating in rural areas. The majority of the tools offer fixed housing solutions and as a result insufficiently address the differences between individual households. Their capacities or preferences for improved housing might only partially reflect in the solution and therefore requires a more tailored solution. One which reflects the inhabitant's capacities and preferences for improved housing.

Support tool findings: The main problems found in the analysed support tools can be divided into two categories. The first, solely focus on tools for implementing practical material solutions (Rigassi, 1985). The second, offers tools for enabling the local production of materials and tools (Acioly, 1992). Both categories do not address the analysis of inhabitant capacities and lack a decision model for practitioners to identify a suitable housing solution. Although they do offer practical guidance in implementing solutions these might not be suitable in relation to available resources and skills. Moreover, they lack the inhabitant's involvement in decision making jointly with the practitioner. Therefore, the tools have a highly explicit nature and lack inclusion of the communities' tacit knowledge.

General support findings: can also be divided into two categories. The first category, supports sustainable housing through national or governmental trainings (Council of Europe, 2005). The second category, offers theoretical guidelines and are not directly applicable into working context (Cole & Lorch, 2003). This does not mean that the sum of all available information cannot be compiled to an appropriate

support tool, however, the efforts made to amass the information often remains on the level of a catalogue (UN-Habitat, 1988), directory (UN-Habitat, 1997a) or bibliography (Raghavan, 2001).

Two manuals stood out from all of the studied tools: *the Design Management of Community Projects, a Team Approach* (Hubbard & Ennis-Applegate, 1988) & *Catalogue of Training and Information Tools on Community Participation in Human Settlements* (UN-Habitat, 1988). Although the first was mainly tested in three pilot workshops on government extension staff, NGOs and community leaders, the structure, topics, methods and handouts are directly applicable in an aid scenario. Addressing key topics in project development, (theory, trainings, etc.) execute a needs assessment (mapping, observation, interview, focus-groups, etc.), make a project planning (problem solving, goals, objectives, action plan, planning, testing, etc.), implementation (management and monitoring) and evaluation/measuring the impact. The second tool provides an overview of many practical trainings, manuals and tools. A selection of these are used to articulate the key-components of the support tool in section 4.2.5.

The other tools analysed in this section only addressed a fraction of underlying theories, lacked a variety in methods, were unable to measure the impact in situ and generally could not be directly used in the field (realization of projects in rural developing countries). The next section will focus on the literature review of support tools developed after 2000.

4.2.2 Support tools after 2000

This section will address different types of support tools within three different groups: general volunteer tools (preparing, management, monitoring and impact), tools developed for engineers and architects working in vulnerable contexts and tools for community/inhabitant participation.

4.2.3 General volunteer tools

General volunteer tools provide the notions, theories and approaches developed for volunteers operating in the field of development aid. These tools are not all specific to realize buildings, however, help volunteers working in vulnerable contexts. Examples are: *Volunteer Management Toolkit* (VODG & NCF, 2016), *Project*

Design Manual (ILO, 2010), *Resilient Development Practical Guide* (Cavero, 2018), *Volunteer Handbook* (Habitat for Humanity, n.d.; Peace Corps, 2017). Although these manuals help volunteers to prepare, plan, monitor and evaluate projects, they are limited in explaining practical issues, for example: appropriate behaviour, communication and clothing.

As mentioned in the first chapter, inhabitant self-reliance regarding the introduced aid is an important departure point. A notion extensively debated at the end of the 90s and the decades after (Campfens, 1997; Oakley et al., 1991; Saugestad, 2001; Shuman, 1998). However, useable outcomes remain general: approaches, strategies, case study, theories and tendencies. Therefore, making it difficult to apply them directly in the field. One of the most elaborate publications on self-reliance in relation to housing was published by UNHCR (2005). This handbook, consisting of two volumes, elaborates on the importance of self-reliance, applicable toolkits describing step by step how to evaluate self-reliance and how to promote and support this through development. The books are written in the context of refugees and comparable to the previous section mainly address trainings on a governmental level. The support for application in the field is limited and is not practical in executing inhabitant self-reliance evaluation. Although the presented tools have useful parts, they are in their articulation not useable for engineers and architects operating in vulnerable contexts.

4.2.4 Tools developed for engineers and architects working in vulnerable contexts

This category elaborates on a broad scope of available tools in the field of engineering in the built environment and architecture. As this section will show many available tools are not specifically developed for housing design or development, however, provide with useful frameworks, approaches and methods.

Directly Applicable Tool 1: The *Sustainable Building Assessment Tool (SBAT)* is the first category of directly applicable impact tools. A version of the tool was developed in South Africa (Gibberd, 2002), to help assessing how buildings can support sustainability in developing countries. Evaluating environmental, economic and social indicators, emphasising on aspects like locality of used materials and inhabitant participation. However, available publications only present projects ranking and do not elaborate how scores are weighed or how the tool operates. The tool itself is used by a company and cannot be freely used by individuals.

Directly Applicable Tool 2: Later versions of the SBAT (Residential Design 1.04, Gilbert, 2015), became increasingly commercial, making it inaccessible for low income communities. Which follows the trend in the development of SBATs (ARRA DIG, 2009; Krídlová Burdová & Vilcekova, 2015) which are often emphasizing on commercial projects, excluding important social and cultural factors. Moreover, the SBATs available for developing countries are difficult to apply in different contexts (Bhatt, Macwan, & Bhatt, 2012) and lack precision for individual inhabitants & community capacities.

Empowerment & Self-help Tool 1: The slum dwellers federations in India gives an elaborate overview of case studies, executing various tools and methods (survey, mapping, house modelling, etc.) for inhabitant empowerment (Patel, 2004). However, the case studies briefly address applied methods & tools making it difficult to know the specifics to implement advised approaches in the field. Other case studies underline the importance and key factors of empowerment theory (Pattison, Strutt, & Vine, 2011), describe global innovative government organizations (Mitlin & Satterthwaite, 2013), policies (Mullen & Management, 1999), and the role of inhabitant empowerment by architects (Serageldin, 1997). Which leaves the case studies on a general explanatory level, insufficiently addressing the practicalities for implementation

Empowerment & Self-help Tool 2: An important aspect of inhabitant empowerment in the field of housing is to stimulate self-help. *The Manual for Organized Self-help Housing Densification in Eastlands, Nairobi* (Makachia, 2005), explains how to analyse existing context and articulate a self-help design based on inhabitant capacities. Elaborating on the used methodologies, process and outcomes. An equally detailed investigation was made by Davidson et al. (2000), although targeting communities, not individual inhabitants. A similar approach was used in the study: *Improvement of Housing Conditions and the Performance of an Aided Housing Scheme in selected rural areas of Kenya* (Müller & Job, 2006). Presenting a detailed analysis of a housing scheme in rural Kenya. Explaining the methods to map and identify housing needs. Examining the financial sustainability of the underlying mortgage system and identifying the main drivers. Which can be used in locating the right inhabitants within a larger area to offer support. However, solely focuses on financial drivers (mortgage attribution). Most of the developed self-help support focuses on developing and evaluating policies for enabling self-help housing (Baquero & Arroyo Baquero, 2013)c or present cases which are not applicable to development context (Benson & Hamiduddin, 2017)

Design Tool 1: One of the most well-known books in the field of anthropological housing analysis is *House, Form and Culture* (A Rapoport, 1969). How Rapoport describes and captures existing housing around the world in detailed sketches is very useful in conducting observations. Giving detailed insight on how to analyse traditional housing typology, spatial relation between house and community, interior housing program, local materials and building knowledge. More importantly relate these aspects to culture, climate and topography. However, the observations lack a thoroughly executed anthropological methodology and as a result allow a socio-cultural bias. As the author does not describe the applied methodology, it is difficult to reproduce it by other professionals.

Design Tool 2: *Ground rules in humanitarian design* (Chun & Brisson, 2015), Is a collection of articles and cases in the field of Humanitarian design. Outlining an important framework for designing for impoverished communities, integrating culture, art, architecture, economy, ecology, health, and education. Although the individual cases present interesting insights, they only give a general overview. There is no explanation when which tool or method should be applied nor under which circumstances. Moreover, they lack a structured and practical approach for architects to apply them in practice.

Design Tool 3: In *Affordable house designs to improve health in rural Africa: a field study from north-eastern Tanzania* (von Seidlein et al., 2017) six prototypes houses were designed and built from lightweight and natural materials. The described methodology focused mainly on mosquito and temperature reduction.

Design Tool 4: The study *Flexible Design and Construction Strategies for Self-Help Housing in Botswana* (Jobe & Williams, 2016) has a similar approach in analysing context and articulating a design. However, inhabitant empowerment (participation) is low, here the involved engineers and architects, articulated a solution based on their chosen parameters. Not considering the wide range of inhabitant abilities and desires regarding their housing needs.

Architect Manual 1: The most frequently used book by architects in the field is: *the barefoot architect* (Lengen, 2008). The book describes all the basics needed to understand climate, available materials, construction, energy and sanitation. Using simple sketches and brief explanations Lengen provides with a tremendous scope of tools and methods, ranging from making basic soil test to weaving lightweight separation walls. Although similar attempts have been made, they either focus only on one part of the building process, are not applicable in other contexts or lack inhabitant involvement in the decision-making process.

4.2.5 Tools for community/inhabitant participation

The last category focuses on tools that emphasize on community and inhabitant participation. Continuing the discussion raised in Chapter One where inhabitant participation is a main contributor to level of self-reliance in relation to their housing.

Participation tool 1: *Community participation methods in design and planning* (Sanoff, 2000) is still the most elaborate guide how to involve communities into design processes. This guide written from the professional's perspective elaborates extensively on case studies (rural and urban) around the world and in detail describing used tools and techniques (questionnaires, manuals, etc.).

Participation tool 2: A similar more contemporary study, *Architecture is Participation* by Hofmann (2014), evaluates recent case studies, explains the used approaches and methodologies. This study however remains on a general level and does not offer the tools and techniques used, therefore, make it difficult to copy them for own application.

Both publications fail to provide a framework, which tools and techniques can be used in a given context. Caroline Clark (2001) does offer a toolkit for the self-assessment of partnerships in community participation, however does not offer the tools and techniques needed to stimulate participatory processes in the actual planned activities.

4.2.6 Goal 2: Problem expressed in practice (practitioners)

The initial literature review showed that at this moment a practical guide for practitioners realizing housing based on the inhabitant capacities does not exist. Therefore, this section highlights the key literature on inhabitant capacities evaluation from the previous section and elaborates how these can be used in articulating alternative housing. These are then used to describe the required design support. Two of the most elaborate manuals are: *Engineering for sustainable human development: a guide to successful small-scale community projects* (Amadei, 2014) and *Field guide to environmental engineering for development workers* (Mihelcic et al., 2009). They both qualify as a framework which help engineers conduct small-scale projects in vulnerable communities. Combining concepts and tools traditionally used by development agencies with techniques from project management and systems thinking.

Both guides include many general theories, methods, tools and examples, moreover, are useful in the field in helping vulnerable communities. They, however, do not elaborate on housing development, lack practical explanation applying them in the field, do not focus on inhabitant capacities, and miss a focus on inhabitant self-reliance in relation to their housing. Both guides present a practical structure (step by step manual) which is used in articulating the new support tool. This general framework provides a departure point to start filling in the gaps between these guides. From the engineering and architectural point of view the *barefoot architect* (Lengen, 2008) provides many of the missing practical issues needed to work (design, test, experiment and build) in the field. However, misses the methodologies and practical handouts on the design and management of community projects, which are offered in *The Design & Management of Community Projects - A Team Approach* (Hubbard & Ennis-Applegate, 1988). Compiling all these elements together leaves one topic open: community participation. Here the catalogue of training and information tools on community participation in human settlements (UN-Habitat, 1988) and *Community participation methods in design and planning* (Sanoff, 2000) offer the required methods and approaches. Based on these findings the next section will describe the identified key components of the design support.

4.2.7 **RQ3: Which factors hindered housing improvement (practitioner)?**

The new housing project and other local examples of improved housing on Mt. Elgon showed that current desired housing mainly depends on external materials and labour. Therefore, currently only accessible for inhabitants with high financial capacities. Moreover, does current desired housing on Mt. Elgon increases the inhabitants' dependency on external materials and labour. This is mainly due to the mismatch between the existing inhabitant capacities and the capacities they require to sustain improved housing. Additionally, inhabitants are increasingly excluded from the realization process of their improved housing. Indicating that practitioners involved on Mt. Elgon lack the training to develop housing solutions within the inhabitant's capacities and therefore depend on support tools. The state-of-the-art analysis showed that a support tool addressing inhabitant capacities in the development of improved housing does not yet exists. Concluding that the preliminary key factors that hindered the realization of improved housing by the practitioners are:

- Practitioners introduce housing solutions which do not suite the existing inhabitant capacities

- Practitioners largely exclude inhabitants from the realization process
- Practitioners insufficiently offer alternative housing solutions that meet both the inhabitants' preferences as well as their capacities.
- Lack the appropriate tools to evaluate inhabitant capacities and incorporate these in alternative housing solutions

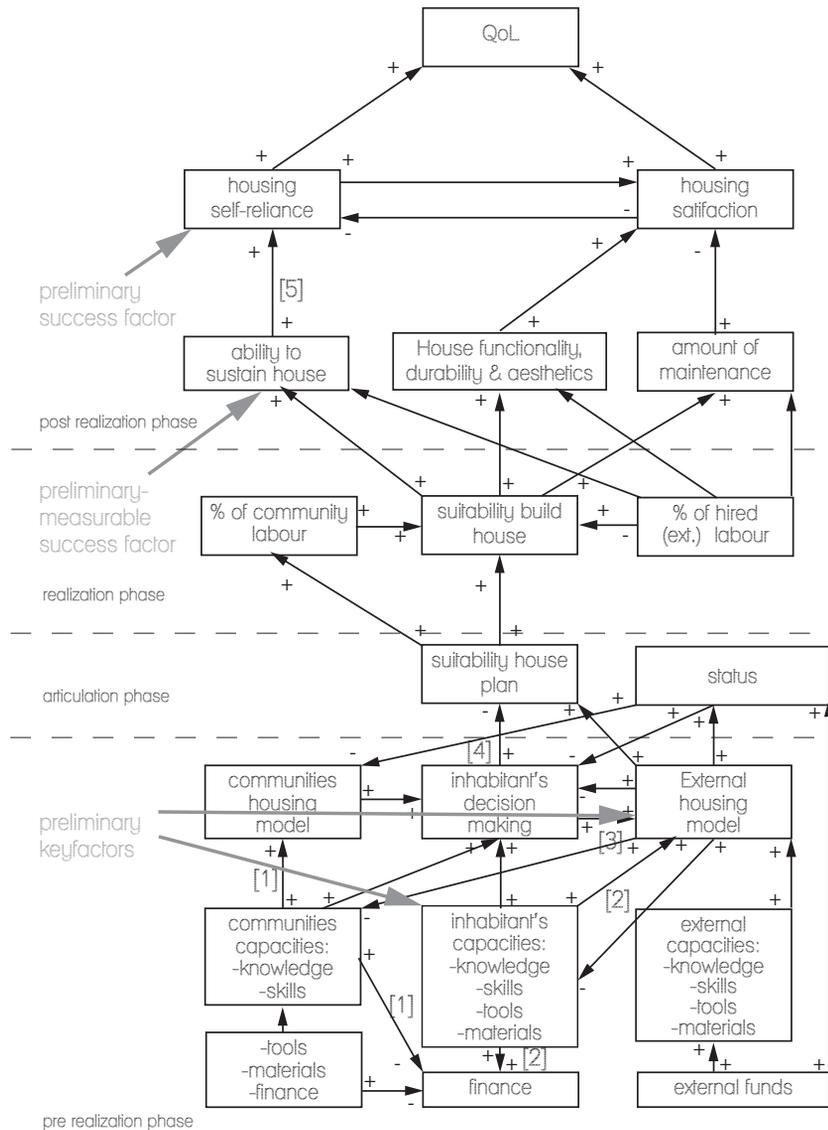


FIG. 4.15 Initial impact model (author, 2017)

These results are also rendered in Figure 4.15. Here the inhabitant capacities are pinpointed as preliminary key factor together with the inhabitants need for external assistance in articulating improved housing.

4.2.8 **RQ4: What are the necessary key-components of the design support?**

Based on the key-literature described in the previous sections and chapters, this section describes the key-components, organized according to previously studied frameworks (Amadei, 2014; Lengen, 2008; Peace Corps, 1964).

- Key Topics (ILO, 2010; Sanoff, 2000; UNHCR, 2005): will address the main goal (self-reliance of inhabitants in relation to their housing), objectives and topics. This section is meant to increase understanding in the underlying motivates and theories of the overall support.
- Sensitive context approach (Liamputtong, 2006): will explain the sensitivity of working in a vulnerable community. Elaborating on desirable: behaviour, documentation, clothing and such. This section is meant for people who never worked in a vulnerable rural community before.
- Daily routine, interview (Creswell, 2013; von Seidlein et al., 2017): is meant to get a first understanding over every day activities. Increases understanding of cultural and social differences, moreover, helps preparing in later stages of, mapping and observation.
- Dream-house-game (P. Ellis, 1983; Granath J.A., 2001; Hofmann, 2014; Lee, 2006; Sanders, Brandt, & Binder, 2010): this participatory section will help to understand the desires and preferences of the entire family. This will in a later phase be used to project the actual inhabitant capacities on.
- Preparatory house and context mapping (Gallant, 1977; Lengen, 2008; A Rapoport, 1969): will explain how to make an extensive site survey. Starting with the general basics for people who never made such a survey. Later on, elaborating on specific elements that will need to be analysed in preparation for the capacity analysis.
- Inhabitant capacity evaluation, observations (Thakur, 2016; Toffin, 1994): In addition to the context mapping an in-depth understanding of daily activities and spatial usage is needed. This section will attribute the theories on observation and how this needs to be conducted in this type of context.
- Context depth analysis(Karanja, 2010): will explain how to make an extensive site survey. Starting with the general basics for people who never made such a survey. Later on, elaborating on specific elements that will need to be analysed in preparation for the capacity analysis.

- Inhabitant capacity evaluation, interviews (Creswell, 2013; von Seidlein et al., 2017): is the final step in getting a full understanding of all the existing capacities of the inhabitants, relatives and community members. Compiling a list of all skills, materials and tools available.
- Capacity-informed decision-making (gap: methodology does not exist): based on the identified capacities this section will help to articulate three design propositions and developing them with the family to a final design.
- Planning with inhabitant capacities: with a project based on available capacities, most of the elements needed to construct the house will need to be collected, borrowed, harvested and such. This is a time-consuming effort unknown in regular project processes. This section will help to plan the activities and needed capacities.
- Training & Effective knowledge transfer (Fisher et al., 1994b; Fisher, Tees, & UN-Habitat, 1994a; UN-Habitat, 1997b; Wynn, 1986): knowledge transfer to the inhabitants is the most crucial factor in their ability to maintain, extend or replicate to offered solution (materials, construction and design). This section will help to register the existing skill levels and plan trainings accordingly on the job.

4.2.9 Hypotheses

In reflection to the survey outcomes the following hypotheses can be confirmed:

Hypothesis 7: The literature review confirms that currently a Support Tool which evaluates and integrates inhabitant capacities into the articulation of improved housing does not exist.

4.3 Secondary Outcomes Descriptive Study 1

The most important outcomes of this research are addressed in the answers of the identified research questions, in this section RQ3&4. However, this research also develops approaches, methods and tools which are tested and evaluated in practice. These identified criteria, experiment design, or practical tools (guides, instructions, etc.) are secondary outcomes which are useful for other researchers. The undertaken research steps are therefore valuable for their developed products (methods, frameworks, etc.) or as a case study for the use of produced data. This last section therefore addresses these practical outcomes and closes by stating the research questions for the Descriptive Study 1.

The household survey (section 4.1) presented an elaborate case study amongst four communities and 200 households on Mt. Elgon. The section provides with an approach to identify problems in situ and address success-, key-, and fail factors. Proving that the DRM provides with a framework to identify and confirm the inhabitants' problem in situ. The outcomes of this section can be used as followed;

- How to select a representative location
- Sample criteria for the targeted communities & interviewees
- Sample criteria for the survey interviewers
- Appendix A: Provides with a detailed example instruction for interviewers conducting interviews in developing countries. The instruction addresses the handling of:
 - recruitment of participants
 - media recording
 - interview venue
 - selecting of participants
 - breaks
 - (financial) compensation
 - coding
 - ethical issues
- Appendix B: Provides with an example guide for interviewers conducting interviews in developing countries. The guide addresses:
 - introduction to the research
 - explanation why the interview is conducted
 - examples of opening questions to make the interviewee relaxed
 - detailed question about the interviewee's current and desired housing situation
 - consent form

- Appendix C: Provides with an example of how the interview guide can specified and transferred into a Google Form, for online surveying.
- Appendix D: Provides the dataset (Smits, 2017a) following from the online survey of two hundred participants. This data can be used as a representative case study of rural communities in Sub-Saharan. The data presents:
 - gender, marital status and age
 - occupation, income (quantified) and type of income (stable/fluctuating)
 - number of children and age of children
 - size of current house, amount of rooms and type of rooms
 - type of materials used, local availability of materials
 - landownership
 - available building knowledge, required hired labour
 - housing suitability, desired solutions/housing and desired housing requirements
 - willingness to learn alternative solutions
 - willingness to help community members building improved housing
 - willingness to help realizing public buildings
- Appendix D: Provides the dataset (Smits, 2017a) following from the online survey

The state-of-the-art analysis (section 4.3) presented a framework to evaluate existing support tools based on the identified criteria of the initial reference model. Confirming that a Support Tool addressing the key-components does not yet exists. Proving that the DRM provides with a framework to identify and confirm the practitioners' problem in situ.

4.4 Research Questions

Based on the found Key Components the following research questions are identified for the Prescriptive Study 1 phase.

TABLE 4.7 Research Questions PS1-Phase

DRM Stage	Research Question(s)	Goal	
Prescriptive Study 1	RQ5	What helps in approaching a vulnerable context?	Goal A: Vulnerable context approach: Undesirable & desirable behaviour, appearance and communication Goal B: Vulnerable context methodology: Daily switching of actor & observer role
	RQ6	How can inhabitant capacities concerning their built environment be evaluated?	Framework for inhabitant capacity evaluation: Mixed method (interviews, observations, games & context mapping)
	RQ7	How can inhabitant capacities regarding their built environment be integrated in solution formulation?	Methodology for capacity informed decision-making.
	RQ8	How can the impact of the support be measured?	Framework for impact measurable (success) criteria: - Baseline in-depth interviews with inhabitants - Impact in-depth interview with inhabitants and community members
	RQ9	How can the suitability of the support be evaluated?	Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.



5 Prescriptive Study 1

The previous chapter described the capacity gap the inhabitants of Mt. Elgon experience in articulating improved housing by themselves. It concluded that the inhabitants rely on external professional support and advise in pursuing improved housing; moreover, it clarified the key criteria for supporting professionals in advising inhabitants. This chapter converts these key criteria into appropriate design support in three ways: firstly, by noting how professionals can approach a vulnerable context like Mt. Elgon, secondly, by demonstrating how professionals can evaluate inhabitant capacities and integrate these into housing solutions, and thirdly, by showing how professionals can effectively train inhabitant(s) about the housing solutions. The outcomes of this part were published in *Frontiers for architectural research*¹. The last section of the chapter provides the framework in which the impact of the support and the extent of its suitability can be measured. The outcomes of this section were published in the journal for *Smart and sustainable built environment*². The next chapter explains the quasi-experiment in which the support was tested on Mt. Elgon in 2017. Moreover, it presents the impact of this experiment and the suitability of the Support Tool.

¹ Smits, M. W. M. (2019). Framework for capacity based sustainable design & development: towards resilient communities. *Frontiers of Architectural Research*. <https://doi.org/10.1016/j.foar.2019.07.001>

² Smits, M. (2019a). A quasi-experimental method for testing rural design support within a DRM framework. *Smart and Sustainable Built Environment*, 8(2), 150–187. <https://doi.org/10.1108/SASBE-11-2017-0067>

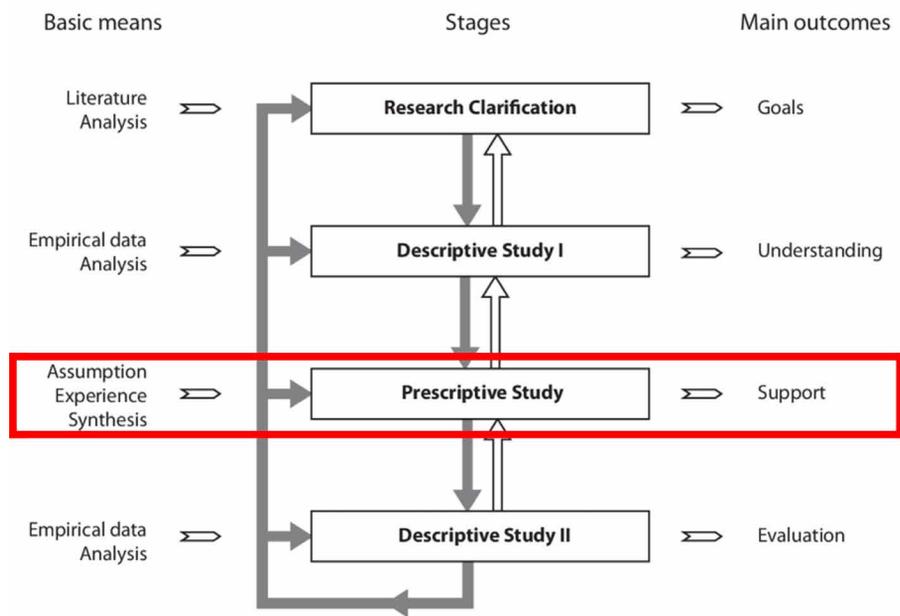


FIG. 5.1 DRM Framework (Blessing & Chakrabarti, 2009)

TABLE 5.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)		Goal
Research Clarification	RQ1	What are the main contributors to inhabitant's self-reliant housing?	Problem identification Hypotheses and Measurable Success Criteria
	RQ2	Are inhabitants able to articulate desired housing by themselves?	Addresses hypotheses 1,4,6 Answers RQ1+RQ2 Development of RQ3+RQ4
Descriptive Study 1	RQ3	Which factors hindered housing improvement?	Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4	What are the necessary key-components of the design support?	Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

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TABLE 5.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)		Goal
Prescriptive Study 1	RQ5	What helps in approaching a vulnerable context?	Goal A: Vulnerable context approach: Undesirable & desirable behaviour, appearance and communication Goal B: Vulnerable context methodology: Daily switching of actor & observer role
	RQ6	How can inhabitant capacities concerning their built environment be evaluated?	Framework for inhabitant capacity evaluation: Mixed method (interviews, observations, games & context mapping)
	RQ7	How can inhabitant capacities regarding their built environment be integrated in solution formulation?	Methodology for capacity informed decision-making.
	RQ8	How can the impact of the support be measured?	Framework for impact measurable (success) criteria: - Baseline in-depth interviews with inhabitants - Impact in-depth interview with inhabitants and community members
	RQ9	How can the suitability of the support be evaluated?	Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.
Descriptive Study 2	Test RC 1-9		Goal A: Evaluate support impact Goal B: Define the recommended adjustments to the support Verification of the Research Factors & Key-components
Conclusions			Verifications Hypotheses

5.1 RQ5: What helps in approaching a vulnerable context?

This section will address the preparations that will need to be made before volunteer's departure and in the first weeks of deployment. Starting with the key-topics; here the arguments from the first chapter of this manuscript were used to explain the most important subjects and referred literature sources. Every key-topic is concluded with a short literature section, stating the most important literature sources. The tested support book is available in Appendix E.

Key Topics (chapter 2, Support Tool)

The Preface of the support gives a general background on the facts and figures on informal housing, poverty and vernacular architecture. Problematizing that currently the provision of low-cost housing is a tremendous task and is only growing each day. Suggesting that to relieve this issue the help of local operating architects and engineers is much needed, more importantly, that the inhabitants themselves play an important role in their own development. The section finishes by explaining the importance of inhabitant self-reliance and specifically regarding their housing (advised literature to the Support Tool user:: Lélé, 1991; Nel & Binns, 2000; Smits, 2014).

In the Development aid Frameworks section of the support, different perspectives on sustainable development theory are explained. Elaborating on how the global approaches over the past century changed and the importance of community-led development in building up capacities. Specifically how the changes in the United Nations policies led to the current applied approaches (advised literature to the Support Tool user: James, Nadarajah, Haive, & Stead, 2012).

The Self-reliance & resilience section presents one of the most important observations made in the overall PhD research: the importance of development and self-reliance in order to sustain sustainable development. Here, too much externally initiated development leads to rapid change, however, decreases the self-reliance. Although, without any external help the level of self-reliance might be high, but the development would take much longer (advised literature to the Support Tool user: Fonchingong & Fonjong, 2003; Idoma & Muhammad, 2013; Li & NG, 2014).

To only focus on the housing development, however, might pose a great threat to the overall Quality of Life (QoL). Therefore, the QoL section of the support helps the volunteer to understand that there are four categories for QoL: physical, psychological, social and environmental (Lucas-Carrasco, 2012). Housing is merely one element in the environmental category and it is therefore important to always consider as many other aspects in the development of inhabitant housing as possible (advised literature to the Support Tool user: Lucas-Carrasco, 2012; Skevington, S, Lotfy, & O'connell, K, 2004).

The importance of inhabitants' existing housing capacities were explained earlier in the context of vernacular architecture. One of the major elements in these capacities is building knowledge which can be explained by three theories: *Collective Intelligence*, *Embedded Knowledge* and *Situated Learning*. The knowledge is collective because traditional housing production was realised by the help of community members, embedded because parts of the knowledge were practices in every day household activities and situated because the rules are not set and change according to circumstances (advised literature to the Support Tool user: Cole, Leaman, & Seaden, 2000; Collins, 1993; Leimeister, 2010).

The most crucial introduced notion within the overall PhD research is the *Capacity-based Development*. Therefore, the Capacity based development section of the Support Tool starts by introducing the central theories of the *Capability Approach (CA)*. Elaborating how commodity enables capabilities, lead to a functioning and potentially sustains utility. Followed by the most important housing capabilities introduced by Li&NG (2014). Because an elaborate methodology for inhabitant housing capacity evaluation does not exist yet, the main aim of the support is to describe this framework (advised literature to the Support Tool user: Robeyns, 2005; Sen, 1993; Willer, 2002)

The literature review in the previous chapter pointed towards one complementary book supporting practitioners in the field: *The Barefoot Architect* (Lengen, 2008). For this reason, the last key-topic explains the importance of the book and its relation to the Support Tool (see Appendix E).

Introduction to the family (chapter 4, Support Tool)

As previously mentioned, the first weeks of deployment in a vulnerable community are critical. Although many general (ethical) guidelines exist, few are developed specifically for building engineers providing practical guidelines working in the field. It is important to make students and professionals aware of cultural differences in communication and clothing. Moreover, suggesting practical socially desirable behaviour operating in this type of context. As the research aims at articulating self-reliant housing solutions, it is of vital importance that families participate in the process as soon as possible. Therefore, the Support Tool helps to explain to the family what the motives of the team are and what they expect. In the same time allowing the family to share their initial thoughts. The Support Tool therefore advises the team to introduce their own family, living situation, interest and such by sharing photos. Followed by the team's intent and how this relates to articulating a self-reliant housing solution for the family. Explaining to the family what self-reliance is, why it is important for the family and how it is integrated in the project. The family has the time and ease to address questions, hopefully resulting in a sensitive, calm and respectful start of the project.

RQ 5: How can both engineering student and professional approach a vulnerable context?

Answer: By offering the user³ relevant background information on the importance of self-reliance in articulating sustainable housing. How self-reliance can contribute to the QoL of rural inhabitants in development countries, pinpointing collective intelligence as key factor in realizing sensitive and sustainable building solutions.

Besides offering theoretical background information the user is provided with practical and applicable steps to work in the field. These steps advise on how to dress and communicate appropriately. Moreover, contribute a sensitive introduction to the family, explain the importance of self-reliance and how it can be attributed in realizing suitable housing for the family.

³ User: the person(s) using the support tool

5.2 **RQ6: How can inhabitant capacities regarding their built environment be evaluated?**

In this section, a framework to evaluate inhabitant capacities in relation to their built environment is described. Some of these capacities are easy to identify for both the inhabitant and practitioner. Tools such as a hammer or saw can be found within the household and are directly related to the production of the house. The same counts for income or available resources such as: thatch, soil or wood. However, there are many capacities that are less obvious. Some capacities like tools, skills and resources are not directly related to the production of housing. This section describes the steps required for the evaluation of inhabitant self-building, proximal, and peripheral capacities. Each topic (in the Support Tool these are divided in chapters) starts with a summary of what the chapter of the Support Tool entailed. The tested support book is available in Appendix E.

Preparatory house and context mapping (chapter 4, Support Tool)

To better understand how the family currently lives and how they use their space, this section of the support explains how their compound can be mapped, measured and drawn: individual structures, interior, family compound and community area. Most of the rural families have more than one structure on the compound and have a multitude of functions taking place between them. Some functions can be clearly identified (such as cooking) some are more difficult due to their temporal nature (studying). To be able to mark actions in the field (eating, washing, studying, etc.) detailed floor plans, sections and façade views are needed to analyse the interiors (functions and furniture) of all the houses within the family compound and their surroundings. In this way during the observations (chapter 5 support book) all basic documents needed are ready to map the activities taking place. Most activities take place in and around the house, however, many of them also in the surroundings. To better understand important places in the surrounding (water points, school, church, etc.) and how they relate in terms of infrastructure, an additional map of the surroundings (max 0,5-1 km radius) is needed. The outcomes of this section offer a part of the existing family capacities regarding their existing housing situation.

Before any capacity analysis can commence the general context of the location needs to be understood. This chapter of the support book does not debate the

importance of mapping (de Jong & van der Voordt, 2002), various types or compare the benefits of mapping. It accepts that making an inventory of the existing context is common practice in architecture. However, it does state the importance for practitioners to start with a preparatory inventory to evaluate and localize inhabitant capacities in a broader perspective. Therefore, a general context inventory of the houses and family plot/compound needs to be made. This inventory can then be used to map inhabitant capacities gathered in observations and interviews (explained in the upcoming subsections). Chapter four of the support book describes that the inventory starts with analysing the house(s) of the family within the context of their plot: measuring the individual structures to produce facades, floor plans and sections sketches (see: Figure 5.2) indicating the position of furniture, objects (containers, shoes, clothing, etc.) and openings (doors, windows and roof); gathering all information by drawing the plot with all individual structures.

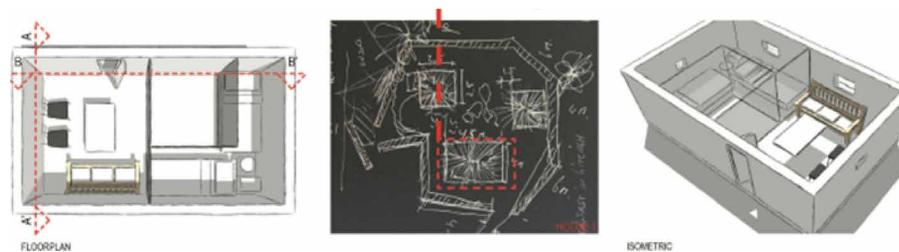


FIG. 5.2 Example inventory of a family on Mt. Elgon (author: M. Smits)

Many of the inhabitants' capacities are peripheral, for example: they do not own the resources and are not located on their plot. They rely substantially on the support of others to produce their built environment. Especially, neighbours, family, friends and community members made the skills and tools used in building the existing house available. Therefore, it is essential to continue to make an inventory of the surrounding area. The next part of the described support emphasizes on an area in a 500-1000m radius around the family plot, see Figure 54.



FIG. 5.3 Target area for context analysis on Mt. Elgon of approx. 50 families (author: M. Smits)

This 'initial' proximal and peripheral inventory helps to locate borders, water, infrastructure, trees, water points and general places of interest. It aims at helping the practitioner to get a general notion of the direct surroundings of the family. Based on the combined inventories (plot, proximal and peripheral) now both the family capacities and community capacities can be registered and located, also explained in consecutive chapters.

Observing inhabitants on their own and proximal capacities (chapter 5, support book)

In the previous subsection the area in which the capacities are being evaluated was explained. This subsection will elaborate how the first inventory of the capacities of the family in the everyday life can be made. This means looking at when, where and how capacities (resources, tools and skills) are used, stored or shared. It is important to understand that the presence of a visiting practitioner in such context has a tremendous effect on the inhabitant's behaviour. This might influence behaviour and ultimately the practitioner might misplace or misread the inhabitant's capacities. Therefore, to get an in-depth understanding, it is important to evaluate the inhabitants before actively engaging⁴. Observation is a suitable methodology to systematically record people's behaviour, actions and interactions (Hennink et al., 2010).

⁴ To actively engage: any other methodology or action that requires direct interaction between practitioner and inhabitant.

The level of engagement of the observer can normally range between participating fully in everyday activities (participant observation) and not participating at all in any activities (non-participant) observation. Although, it is commonly argued that not participating in practice does not exist, as the presence of an observer (person/camera/recorder) requires a level of participation.

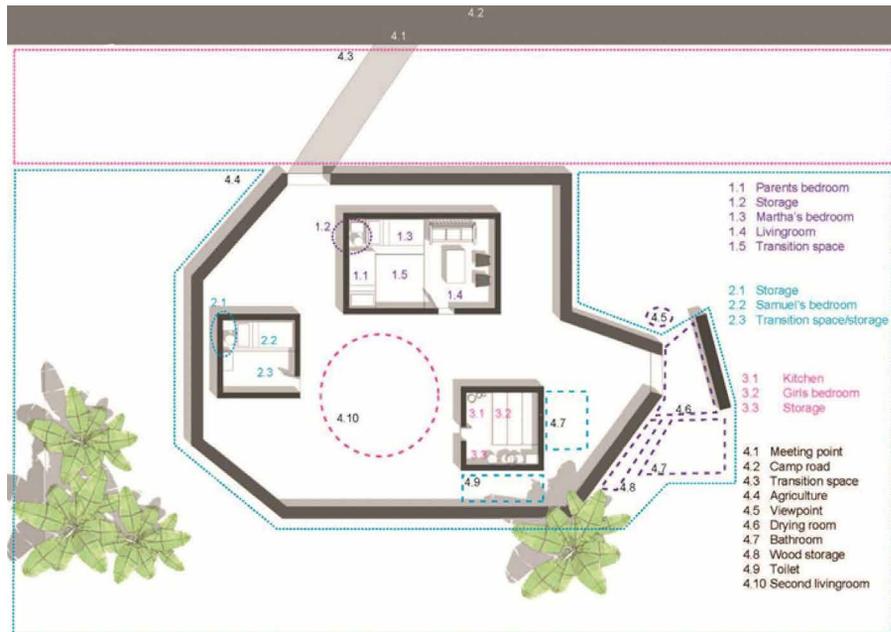


FIG. 5.4 Example of a family compound on Mt Elgon (author: M. Smits)

Non-participant observation might theoretically give the most objective results, however, the presence of the observer might suppress regular every day activities of the inhabitant (Hennink et al., 2010). On the other hand, full participation in everyday activities (helping, asking, sharing, etc.) changes the behaviour as well. The support uses a partially engaged participant observation. Here, the observer can help in everyday activities, however, is requested to only engage in a supporting role (not sharing ideas, perspectives, etc.). To get a broad understanding on the capacities of the family as a whole, every family member will need to be observed for one whole weekday and one weekend day. Based on the previously made maps (inventory) the observer is able to mark where each capacity is registered, see Figure 5.4. To help the observer note the various capacities a registration sheet (see Figure 5.5) was made to track the activities and related capacities during

observations. Everyday activities such as cooking, cleaning, washing, water fetching, etc. show the inhabitants physical capacities (resources and tools) and how they are used in activities (skills). Although an observed capacity might not directly connect to the built environment the observer is able to register it and later decide on its possible use. At the end of the observation the observer is asked to add a picture, sketch or plan that explains, locates or proofs the described activity and capacities.

TEAM: 1
OBSERVATION: MOTHER
DATE: 21-08-2017

Time	Activity	Duration	Where	With Whom	Skills, Tools, materials	Problems/chances/solutions	Comments	Map/Plan/Sketch/Picture
05:00	Arrival							

FIG. 5.5 Example empty observation sheet

Another important finding of the observation is to get a first notion of the social structures of the family (which shared activities do they have). These structures play a vital role in evaluating proximal capacities of the family. On a later moment, identified families can be interviewed and their capacities evaluated.

Context depth analysis (chapter 6, Support Tool)

After making the first context analysis of the house and spending substantial amount of time observing the activities of the family, the findings have to be located in a broader context of the community; starting by adding the identified capacities in the observation to the inventory shown in the first subsection and making a rich complete inventory of the family house and the compound. Mapping the functions, orientation, usage, and public/private relations of the family house in relation to the inhabitants. Next steps in the support, describes how to map: proximal capacities (locating identified capacities from the observation), building typologies (how capacities are articulated into a built form), materials available in the area (locate used building resources/capacities in the area: wood, soil, thatch, etc.), infrastructural capacities (water, firewood & electricity points, farmlands) and public areas. The results of this chapter enable the practitioner to articulate a comprehensive overview of the existing capacities (see Figure 5.6) of the family. Without the help of the family it would be difficult to grasp most of this information which takes place in the family's everyday activities. The next chapter therefore helps to make on analysis on which proximal and peripheral capacities the family and their community have.



FIG. 5.6 Water points and electricity points (author: M. Smits)

Interview inhabitants & community members on proximal and peripheral capacities (chapter 2 & 7, Support Tool)

After mapping and observing the family and their community, the practitioner has a large inventory of capacities. Chapter 7 intends to explore them in more detail (ownership, costs, reward, quantity, etc.) by interviewing the inhabitants and their community. The support intends to help the practitioner to setup a semi-structured interview. An informal or unstructured interview would give too much room for free interpretation and might cause blind spots in the capacity analysis. A structured interview would be too formal and might limit the inhabitants sharing on their capacities. An in-depth interview would allow too much detailed information about the capacities. Although very valuable, in this phase concisely described or quantified resource, tool and skill capacities are needed.

Materials/resources							
nr	item	amount	unit	comments	ownership	name of the owner	payment
1	clay soil	unlimited		soil for making walls	family		free
2	timber		5 st	d=15cm, l=3m	family		free
3	wood: post		11 st	150mm in diameter, l=3-4m	family		free
4	dried grass		150 bundle	s (suitable for roofing)	family		free
5	window		2 st	windows with iron bars 50x60cm	family		free
6	door+frame		1 st	ironsheet door with wooden frame door 1,80x0,8	family		free
7	water	unlimited	bucket	waterpoint	community	common	free
8	clay soil	unlimited			community	Francis Kibue	free
9	rocks	unlimited		rocks for the foundation	community	common	free
10	timber		15 st		community	Francis Kibue	paid
11	wood: post		5 st		community	Francis Kibue	paid
12	dried grass		50 bundle		community	Francis Kibue	paid
13	cement	unlimited	bag		other	shop	paid

FIG. 5.7 Example, overview capacities: materials (Author, 2017)

The practitioners are asked to prepare an interview instruction (based on a given example), which helps them to organize the interview. The instruction section assures that the interviewee is at ease (location, sitting, etc.) and understands the

purpose of the interview (aim, topics, etc.). The interview guide section helps the practitioner to transform the capacities into logical questions for the interview. The questions of the interview guide are organized in four sections:

- resources
- tools
- skills/knowledge
- income/labour

The support explains how interviews have to be transcribed afterwards. This helps the practitioner to go through the answers afterwards and fill in a complete overview of all the capacities (see Figure 5.7). After interviewing the family, the practitioner is requested to repeat the process with the identified friends, family and community members that have certain capacities.

This subsection described how the chapters of the support book help the practitioner to evaluate inhabitant and community capacities in relation to their built environment. Having observed, mapped, located and quantified all these capacities, a very elaborate overview is made. Integrating these capacities into housing solutions is, however, complicated. Therefore, the next section (5.2) will step by step describe how inhabitants' capacities can be used in articulating housing solutions.

RQ 6: How can inhabitant capacities regarding their built environment be evaluated?

Answer: As shown in this section inhabitant capacities can be mainly evaluated through observations and interviews. Therefore, chapter 2 & 7 provide the user with an interview cycle which helps family members to reflect in detail on all their capacities (everything they know and have). Moreover, which of those capacities lie within their community. However, some capacities unknowingly lie within their direct surroundings or everyday activities. For this reason, Chapter 4 helps the user to map, measure and draw the physical context in which the family lives. Which is the basis for the observation Chapter 5, where the user is able to register in detail: the position and circumstances in which the capacities are located or take place. Chapter VI describes an analysis to also register and include the community capacities. Thus, providing the user a wide range of tools to register all inhabitant and community capacities.

5.3 **RQ7: How can inhabitant capacities regarding the built environment be integrated in housing design?**

Comparable to the previous section, this section will use the chapters described in the support to integrate the found capacities into an housing design.

Capacity-informed decision-making (chapter 8, Support Tool)

The core argument of the overall PhD research is that the main contributor to sustainable housing design is the use of available, proximal and peripheral inhabitant capacities in articulating housing. As argued before, capacities are complex and difficult to evaluate, moreover, to integrate into housing solutions. Therefore, this section elaborates on the most important requirements and steps to integrate inhabitant capacities into housing solutions. Here, the departure point for the design process is not defined by the functions, size or aesthetics, but by the available capacities of the family and their community.

As described in chapter 4 one of the sessions the practitioners organised with the family was the dream-house-game (chapter 3, support book). The outcomes of this chapter described: house typology, building methodology and materials. They are used to help the practitioner to compare the desired capacities (by the family) with their existing capacities. In the example shown in Table 6, the desired foundation of a family with low financial capacities is shown in the left column (less than 20.000 KsH - representative for the area on Mt. Elgon) Red indicates the problematic desired materials (costly materials and/or transportation) and in green the resources that are within their capacities. In the right columns the practitioner is able to list possible alternative materials found in the capacity analysis that are within the inhabitants existing capacities, enabling him to openly discuss alternative materials with the family, exchanging ideas and elaborating on why certain desired materials might be less suitable (considering family's capacities) and show what possible alternatives are.

TABLE 5.2 Weighing alternatives – materials (Author, 2017)

Materials (Needed)	Quantities		Available	Transport	Materials (Alternative)	Quantities		Available	Transport
Branches	15,0	m1	yes	0	Branches	15,0	m1	yes	0
Marram Soil	1,3	m3	yes	500	Marram Soil	1,3	m3	yes	0
Cement	1396,0	kg	no	500	Clay soil	1,5	m3	yes	0
Riversand	2,8	m3	no	1000	Soil	2,8	m3	yes	0
Brick	600,0		no	1000	Stones	300,0		yes	0
Small Ballast (1/4 inch)	0,7	m3	no	400	Marram Soil	0,7	m3	yes	0
Transparent hose	8,0	m	no	0	Transparent hose	8,0	m	no	0
Mixed Soil	3,0	m3	yes	0	Mixed Soil	3,0	m3	yes	0
String	22,0	m	no	0	Sisal rope	22,0	m	yes	0

TABLE 5.3 Weighing alternatives – tools cost (Author, 2017)

Tools (Needed)	h	Available	Costs/Reward	Sum
Measure (ruler, tape: 1m1=0,5h)	11,0	no	1100	
Shovel (1m3= 8h)	130,4	yes		
Compacter (1m2= 0,5h)	12,1	yes	200	
Measure volume unit(container, wheelbarrel)	2,0	yes		
Trovel & flatboard	54,0	no	3500	
			4800	4800
Tools (Alternative)	h	Available	Costs/Reward	Sum
Measure (ruler, tape: 1m1=0,5h)	6,0	no	1100	
Shovel (1m3= 8h)	130,4	yes		
Compacter (1m2= 0,5h)	12,1	yes	200	
Measure volume unit(container, wheelbarrel)	2,0	yes		
Stone Hammer	26,0	no	2000	
			3300	3300
Tools (Alternative 2.0)	h	Available	Costs/Reward	Sum
Measure (with feet: 1m1=0,5h)	6,0	no	0	
Shovel (1m3= 8h)	130,4	yes		
Compacter (1m2= 0,5h)	12,1	yes	200	
Measure volume unit(container, wheelbarrel)	2,0	yes		
Break with stones	26,0	yes	0	
			200	200

To make sure sufficient alternative materials for the new house are being considered, the practitioners are advised to make at least 2 alternatives. However, with alternative building materials come alternative tools, labour and skills. Therefore, the support explains how to generate an overview of the alternatives on all the capacities: resources, tools, skills/knowledge and income/labour. Table 5.3 shows three examples for alternative building-tools and shows the differences in required capacities. The financial capacity is solely shown to indicate how much the capacity would cost in case it is not available.

After formulating at least two alternative solutions besides, the practitioners are asked to prepare a presentation for the family. The practitioners present a sketch-design solely based on capacities: resources, tools, skills/knowledge and income/labour. The typology, program and aesthetics of the sketch house are not considered in this presentation, solely the capacities. Per sketch design the practitioners are asked to clearly show what the needed capacities are and to what extent they suit the existing capacities of the family.

After the presentation, there is an informal unstructured interview where the family can ask all their questions and remarks about the presented designs, most likely indicating which elements they like about the sketch designs and which they would like to include in their future house. The last part of the support advises the practitioner to gather all the results from the presentation and interview session and combine them into a final recommendation for the house design. It contains all the resources, tools, skills/knowledge and labour that can be used in making the design. The support does not elaborate how the capacities must be used in articulating a design. It is firmly believed that by analysing the context, making an inventory of the capacities and weighing them against material alternatives this gives a solid departure point for the design process. However, designing and building based on available proximal and peripheral capacities is complex and extremely difficult to organize. Tools must be borrowed, materials exchanged, and labour meticulously planned (which activity, when and who will help with it). Therefore, in the last section of the support, the planning methodology is explained.

Planning with (available, proximal and peripheral) capacities (chapter 9, Support Tool)

With the design finalized and approved by the family, the practitioners are ready to start planning the building activities. The user/community capacity & participation planning section of the support describes how the practitioner can approach planning activities. Step-by-step the process is unravelled roughly into five phases:

foundation, floor, walls, roof and finishes. Per building activity, the practitioner states the necessary capacities: materials, tools and labour, indicating who (from the earlier made capacity analysis) has offered to help and for what reward. When finished the practitioner discusses the planning with the family and makes corrections if necessary (dates might not fit, resources might not be available, etc.). When it is finalised and approved the planning can be presented to the listed community. Per community member, a small letter will be handed out stating what is requested, by when and for what reward. A letter is used to have a physical confirmation of what is agreed upon, however, normally a verbal agreement suffices. The community members are asked to reply to the letter or ask any questions they might have. They are given time to discuss the requested capacities with their family members before agreeing.

As families struggle to generate the financial capacities to pay for help by the community, it is extremely important to enable the inhabitants to for example trade labour instead of financially compensating each other. Helping each other to realise improved housing without the need for large savings and investments, as seen in traditional housing. This system of exchanging materials, labour and tools (capacities) need a thorough registration/value system. Most of the inhabitants on Mt. Elgon do not have the luxury to help each other without asking for something in return. Therefore, the last step of the support describes a registration system (logbook) where all borrowed capacities (tools, materials, labour) are registered in. At the end of each day, a logbook is used to register the shared capacities. Per day, week or activity the inhabitant can write an "I owe you", clearly stating which capacity needs to be given back by when. This can be a certain number of hours of digging, giving back six wooden posts by the end of the year, or a bag of maize by the end of the harvest season. Allowing a more flexible exchange system that follows the fluctuations in income, harvest and available time, empowering the community to plan and realize a more self-reliant and improved built environment.

Planning & tracking training activities for effective knowledge transfer (chapter 10, Support Tool)

During the experiment it became apparent that the skill levels between inhabitants varied substantially. Moreover, that without a proper planning and tracking of the trained skills there might be a risk that inhabitants are unable to sustain their house by themselves. Which is such a fundamental element in enabling inhabitants to maintain, extend or replicate the house, that an chapter was added to the support and handed out to the support groups four weeks into the experiment. This was the only modification of the Support Tool during or after the experiment. As the skills are connected to various building phases, the chapter starts by briefly introducing general planning of building activities. As skill level evaluation seemed challenging during the first weeks of the experiment, the chapter continues by describing a scale of skills levels. Followed by describing how the skills gap can be identified and how a suitable training method can be chosen. The next step is to plan the training activities according to the building phase, skill level (before and after) and duration. The chapter closes of with offering a registration sheet to the user (see Figure 5.8). Here the user can keep track of the executed trainings and the accomplished skill level improvement (see Figure 5.9). This registration is not only useful for the users but can also be used in the improved version of the support for practical examples.

PLANNING OF THE TRAINING

PHASE: Preparation & Position

TRAINER: Dorkas, Peter & Eveline, Michiel & Beata

TRAINEE(S): Dorkas, Peter & Eveline, Michiel & Beata

BUILDING WEEK: 1

Day	Activity nr.	Activity	Skill	Duration	Teaching direction	Starting Skill Level	Targeted Skill Level	Teaching Activity	Teaching impact
04-10	1.1	Locating: Orientation	Builder/Community: orientating social (openings)	3 hours	Inhabitant-Team	3	4	Consecutive practical (inhabitant-tutor)	3-3,5
04-10	1.1	Locating: Orientation	Builder/Community: orientating social (openings)	1 hour	Inhabitant-Team	3	4	Observed practical (tutor-inhabitant)	3,5-4

FIG. 5.8 Example, training planning (author: M. Smits)

REGISTRATION OF THE TRAINING
 PHASE: Preparation & Position
 TRAINER: Corné, Damian (coach)
 TRAINEE(S): Cleophas & Stella, some interested community members
 BUILDING WEEK: 3

Day	Activity nr.	Activity	Skill	Duration	Teaching direction	Starting Skill Level	Targeted Skill Level	Teaching Activity	Teaching impact	What did you train	Photo
18-10	6.1	Foundation Wall	Masonry: mixing wall mortar	1 hours	Team- Inhabitant	2	3	Practical instruction (tutor-inhabitant)	2-2,5	Corné and Damian explained how the mortar ratios can be easily measured and how the mixing should be performed. Cleophas and Stella helped in the mixing.	
18-10	6.2	Foundation Wall	Masonry: laying wall brick	6 hour	Team- Inhabitant	0	1	Verbal instruction with demonstration (tutor-inhabitant)	0,5-1	Corné started with a short instruction in reserved room in the community. Explaining the basics of brick dimensions, the thickness of needed mortar (stability). Afterwards we showed a short movie about masonry works.	

Number	Activity	Feedback Coach
1	6.1	The group is happy and ready to start the teaching day. Corné has the didactic skills to make people feel comfortable however, they have difficulties to follow the explanation sometimes. I suggest that maybe cleophas can translate what is said to swahili which solves the problem.
2	6.2	The group feels distant and passive, they have difficulties to follow what is said although Cleophas is translating. I suggest to grab some bricks so they understand the dimensions and we use cardboard to show the different levels of mortar indicating the strength of the mortar. Especially the cardboard really works as they can feel the differences in strength.

Number	Activity	Decision Trainee
1	6.1	The group is clearly ready to start training on higher levels. We might skip some levels as the group is happy and comfortable to start practising by themselves.
2	6.2	After a brief discussion we decided to ask cleophas to join the teaching team. In this way the group finds it easier to address questions or doubts they have.

FIG. 5.9 Example of an evaluation during the construction of a house (author: M. Smits)

RQ 7: How can inhabitant capacities within their built environment be integrated into housing solutions?

Answer: As previous chapters helped the user to evaluate user capacities, they are left with a complex overview. Chapter VIII of the support describes how these capacities can be categorised, quantified and in case of skills, describes their existing levels. Users can then use this capacity overview as the basis to develop concept building solutions on. Helping the user to ingrate as many of the existing capacities as possible. Moreover, choosing building solutions that are as close as possible to their existing knowledge and skill levels. A major downside on borrowing tools, exchanging materials, or on volunteers, is the planning. Therefore, chapter IX helps the user to make an overview per phase which capacity is required when and by whom. As skills require training and therefore might be time consuming, the user will need to plan and spread these activities over the entire construction period. Enabling the user to generate a clear overview for the family when certain capacities are needed, and which activity is taking place. Securing that the family is in charge and control of all the required capacities. As previously explained, during the experiment the users struggled to track inhabitant skill development. Therefore, a tenth chapter

was added that solely focussed on training the family skills in order to maintain, extend or replicate the house by themselves. Knowledge is a fundamental capacity to the level of self-reliance of the family regarding their housing. Therefore, training the family is vital in integrating their capacities during the construction of their house.

5.4 Quasi-Experiment Design

Testing the support is an empirical investigation in how it influences the decision-making of both practitioners and inhabitants in improving their self-reliance in relation to their housing. A complex set of variables (professional, inhabitants and context) and limited resources, prevent a random assignment (Keppel & Wickens, 2004). Here, the differences in financial capacities or family size can potentially make the research outcomes bias. To limit the variables in testing the developed support the experiment is framed within a quasi-experiment (Bailey, 2008).

The experiments' population size has to be limited to the available resources, however, has to be large enough to prove a significant impact of the support (Scher, Kisker, & Dynarski, 2015) programs or practices. The paper first discusses the issues researchers face when choosing to conduct a QED, as opposed to a more rigorous randomized controlled trial design. Next, the paper documents four sets of best practices in designing and implementing QEDs including: (1. For this reason, the total population size is set on four groups, consisting of one control group. In case group A has a positive impact and group B+C have a negative impact, there is sufficient evidence that the support does not have the desired effect. Without the third group the results might become inconclusive (group A positive and group B negative). In case group A+B have a positive impact and group C has a negative impact, however minimal, there is sufficient evidence for a positive trend. The control group D does not only help comparing outcomes with the groups that use the support, but also provides valuable information on the problems of the entire studied population (within Famia, the investigated community on Mt. Elgon).

The size of the individual teams is set by the support: the team have changing roles in which one team member is active as actor while the other observes and evaluates his team member. The team's sampling is mainly based on financial constraints and convenience (Jager, Putnick, & Bornstein, 2017). It proves difficult to find architects willing to pay for their own expenses while participating in the experiment. Covering

expenses of the eight professionals is not possible and therefore a combination with students keeps the experiment within the available resources. During exploratory meetings with the students they indicated that they are willing to pay for their expenses and therefore allow the experiment to be conducted within budget. Building engineering students from the Avans University of Applied Science, were more than willing to participate in the experiment and pay for their own expenses. Therefore, some of the support sections addressed students and includes a working methodology combining one professional and one student.

Team procedure: The architects applied via a call that was set out in November 2016. Seven architects applied which originated from different countries: The Netherlands, Greece, Kenya and Kosovo. The architect selection procedure had two criteria: applicants need to hold an MSc in Architecture and need to be available during the entire experiment period. Selection of the architects was based on a heterogeneous convenience sampling (Jager et al., 2017). As architect applications were low, and time was limited, therefore, after the application interview every applicant that wanted to participate in the experiment and met the criteria was automatically selected. In May 2017 the last architect applied for the project, making the sum of applicants: four.

The students applied via an internship-call published on the virtual network of the Avans University of Applied Sciences and posters spread over both locations of the faculty. The student selecting procedure had three criteria: students needed to be 3rd year building engineer students and have finished the entire first year curriculum. Selection of the students was also based on a homogeneous convenience sampling (Jager et al., 2017). After the application interview every applicant that wanted to participate in the experiment and met the criteria was automatically selected.

After completing the selection for the experiment, the team composition was randomly sampled (Creswell, 2013). One jar consisted of small notes with the names of the architects and another jar with those of the students. The author was blindfolded and picked one note from each jar. In four rounds the teams were randomly picked.

Inhabitant procedure: To test the support, the four communities of the household survey were chosen. For the comparability of the outcomes the four communities had to be narrowed down to one, which was done using two main criteria: inhabitants owned the plot they lived on and their current houses had to be built with their community members (without external help).

The Japata community (red marker, Figure 5.10) lives on land owned by the government. The Habitat community (orange marker, Figure 5.10) collectively owned their land and was heavily restrained in physical additions or changes to their housing. Most of the Chepchoina (green marker, Figure 5.10) inhabitants rented their house and did not own local land. The community members in Famia (blue marker, Figure 5.10) owned their land and built their own houses (most depending on the community for help). For this reason, Famia was chosen as test location for the experiment.



FIG. 5.10 Map of the selected communities on Mt. Elgon

To find families willing to apply for the experiment, in April 2017 a poster call was put on various locations in the Famia community (blue marker). People were asked to meet the following requirements:

- Legally owning a piece of land.
- Have family members available between August 2017 and January 2018
- Family members should be communicative in English.
- Having and willing to contribute funds or materials for the building.
- The plot should be within ten-minute motorbike ride from Andersen Medical Centre

As families who applied had complex and different capacities, the assignment was nonrandomized (Dattalo, 2010; Thompson, 2012). Therefore, four comparable families were sought to work together with the four identified teams. After two months fourteen families applied for the project. After the application they were then visited by a local social worker that repeated the stated project requirements and participants' responsibilities. One family (application nr.13) withdrew from the project, as they expected to receive a fully funded house. Multiple criteria were set for the families registering for the project, these criteria were: distance from the place of residence of the teams, available budget, condition of the existing house, availability of materials, labour and time.

The first selection round used a score system (0-10) for each criterion, based on the individual scores, seven families with the highest score were chosen. While evaluating the selected applications it appeared that some of the families already had a half-built house, had an unclear family situation or had too few family members. These issues were so fundamental in realizing a new housing or they made too much difference in between the families that a new selection procedure had to be made. Again including all families and setting different criteria, in Figure 5.11 they are prioritized: family has already begun building a new house, availability of the family members, level of English, size of the plot, having children and available budget.

These criteria made sure that the family had the land to build a house on, basic financial means for small parts (tools, materials or labour), and a minimum level of English for basic communication between the team and the community members. Out of the thirteen applications four families were selected which had the most comparable scores, which meant that not the highest scoring families were selected, but the four most comparable. It must be stated that although the families are similar there are still substantial differences (family size, available funds, etc.) and therefore the experiment follows a non-equivalent group design (Kong, Mohd Yaacob, & Mohd Ariffin, 2016; Moenaert & Caeldries, 1996; Wener, 1989) also known as the postoccupancy evaluation (POE).

Family nr criteria	1	2	3	4	5	7	8	10	11	13
1 – construction has begun	1	1	1	1	1	0	1	0	1	1
2 - Availability	1	1	0,5	1	1	-	1	-	0,75	0
3 – Level of English	1	0	0,5	1	1	-	1	-	1	-
4 – Size of the plot	0,75	-	0,25	1	0,25	-	1	-	0,75	-
5 – Having children	0,5	-	0	1	1	-	1	-	1	-
6 – Budget (income and savings)	1	-	-	1	0,5	-	0,25	-	0,25	-
Final score	5,25	-	-	6	4,75	-	5,25	-	4,75	-

FIG. 5.11 Criteria and relative score per family: 0 failed criterion, 0,5 only partially met criterion & 1 fully meeting criterion.

The criteria; budget, number of children, and size of the plot, have a considerable effect on the research outcomes. They defined how much financial means the family had available, determining their expectations for the type of materials, size of the

house and used building method for their new housing. This would enable completely different housing solutions, however, the outcomes would be measurable according to their capacities. Assigning the families to the teams was also randomised sampling (Creswell, 2013). One jar consisted of small notes with the numbers of the teams and another jar with those of the families. The author was blindfolded and picked one note from each jar. In four rounds the four families were linked to their team.

According to the code of ethics (Scientific Integrity Committee, 2012) of the Delft University of Technology a separate research application was written together with partner institute Jomo Kenyatta University of Agriculture and Technology (JKUAT). The quasi-experiment was evaluated and approved by both institutes and later on by the National Commission for Science, Technology and Innovation (NACOSTI) in Kenya. The next section will describe the practicalities of executing the quasi-experiment on Mt. Elgon.

5.5 Executing the Quasi-Experiment

Executing a field experiment in a vulnerable context requires many additional conditions to protect the family, community, team members and the quality of the gathered data. Firstly, to ensure the experiment was conducted within the legal framework of Kenya a legal consent had to be approved. Secondly, as the rural areas of Kenyan are still largely tribe regulated a community consent was required. Thirdly, the financial risks and consequences have to be fully understood and agreed upon by the participating families. Therefore, an elaborate consent procedure was required to make sure the families know and agree to all the conditions of the experiment. An important additional part of this consent was the media approval, where the inhabitants know exactly what is recorded, for what purpose and how media can be shared with third parties. Fourthly, the teams required strict policies to prevent sharing of process or outcomes amongst them and to third parties. Therefore, an elaborate team consent was required to make sure that the teams were operating with full autonomy. This section, therefore, describes the following elements: governmental consent, community consent, family consent; media/financial/cancellation and team member consent/housing/office space/context introduction/nondisclosure agreement & communication.

Governmental consent: According to the Nacosti research permit legislation (NACOSTI, 2017) the County Commissioner and Education Department needs to approve the experiment. Therefore, upon arrival both offices based in Kitale were visited to get the necessary official approval.

Community consent: The most important local level of approval came from the Areal Chiefs (Transnzoia), Community Board and Village Elder (Chepchoina). At this meeting (see Figure 5.12) the author was asked to explain the purpose of the experiment, the content of the support, potential participation of community members and the overall conditions to the research. The meeting was closed with the approval for the experiment to take place in Famia and a short welcoming ceremony for the research team. Over the course of the project three community meetings were held in Famia. In these meetings inhabitants were able to ask any questions or address any remarks they had concerning the experiment. During these meetings there was always an observer present, moreover a local social worker/translator and Village Elder present to guide the meeting.



FIG. 5.12 Areal Chiefs of Transnzoia & Community Board and Village Elder Chepchoina (author: M. Smits)

Family consent: Offering families help, raises many expectations and potential problems. To protect the family from making any decisions solely based on the external help, one of the most important processes in the quasi-experiment was the inhabitant informed consent (Mohler et al., 2010). For one week the author, assistant researcher (Beata Duda) and community worker (Geoffrey Ngeywo) visited all families to informally introduce themselves and to hand out the consent form to the family (see: Appendix F).

The consent form included the following information: identification of the researcher, sponsoring institution, purpose of the study, identification of the benefits for participating, level and type of participant involvement, notation of risks to the

participant, guarantee of confidentiality to the participant, assurance that the participant can withdraw at any time and provided the details of persons to contact if questions arise (Sarantakos, 2005). Moreover, the consent had a threefold varied description of the conditions to consolidate the inhabitants understanding and make sure they could comprehend as much as possible on what they were agreeing on.

Together (researchers, family members and social worker) they read the entire document and then family members were able to address any questions or remarks they might have. The same procedure was followed for the audio-/video consent (see: Appendix G) to explain the procedures for recording and sharing data. The families were then left with the contract and audio-/video consent for a couple of days to discuss them. When they were ready they contacted the author via the provided details and was the baseline in-depth interview⁵ conducted (Muskat, Blackman, & Muskat, 2012), further explained in the next section.

Team consent: After notifying participants about the acceptance of the experiments, multiple (Skype) meetings were held to go through all the conditions of the experiment. After two meetings all participating team members were asked to read the contract and consent form. Afterwards they had the opportunity to ask questions or give suggestions to the contract.

Team housing: Subsequently some of the project conditions were changed in favour of the participants (originally all additional costs: visa, insurance, etc.) were to be financed by the participants themselves). The experiment described individual accommodation for every team, to reduce the risk of sharing information between each other. However, the group as a whole found the costs too high and separate accommodation as socially undesirable. Therefore, the author covered additional costs and allowed the teams to live together. This would make it more difficult between the teams not to disclose any information, however, seemed vital for the teams living quality.

A **Nondisclosure agreement:** was setup in which the teams agreed not to disclose any information between each other or to third parties. The teams were allowed to share everyday issues via social media and with each other; however, anything directly related to the experiment (research, design, decision-making, etc.) was prohibited.

⁵ Baseline interview: measurement of identified variables at the beginning of the study through an in-depth interview, which is used to compare to later impact measurement for impact evaluation.

Office space: Due to the tremendous amount of preparation time in the field, all teams required an office space through the first three months of the project. Although in the first weeks there were some logistic issues every team got their own working space.

Adjustment & integration period: Due to the high altitude and sensitive social/cultural context the first week of the project was planned for context adjustment. As the control group arrived a week after the other groups there was some time for general preparations: basic language courses (Swahili), desirable behaviour and do's & don'ts (based on the support) were addressed. Being a part of an impoverished community means that the teams had to be very conscious in what they say and do while being in the community (Liamputtong, 2006). During multiple sessions the group discussed how to behave in a given scenario (community members asking for money, smoking & alcohol consumption in the community, etc.).

5.6 RQ8: Impact measurement

To measure the outcomes of the tested support in a quasi-experiment setting the evaluation framework targets the families' housing. As the research aims at improving inhabitant self-reliance regarding their housing, the most direct evaluation is through their housing situation. The most detailed outcome of the experiment can be evaluated two to five years after its completion. Here, the factual maintenance, extension or reproduction of the house could be physically observed and easily made comprehensible (survey, interview or observation). However, the timeframe of the overall research is limited (PhD timeframe allows only to test and evaluate the concept version of the support once) and therefore a measurement directly after the project was necessary.

To make the impact visible a baseline measurement (Rubin & Babbie, 2009) is setup before the teams start to test the support. To analyse inhabitant's motives concerning the identified variables (see: Figure 5.13), a structured in-depth interview is formulated (Creswell, 2013), to allow the inhabitant to provide with additional and detailed motives (Guion, Diehl, & Mcdonald, 2001). The interview focusses on understanding the main motivators and barriers for articulating their existing and improved housing. The measurable variables identified in the RC phase (see: Figure 5.13) are translated into sections of the questionnaire used in the interview.

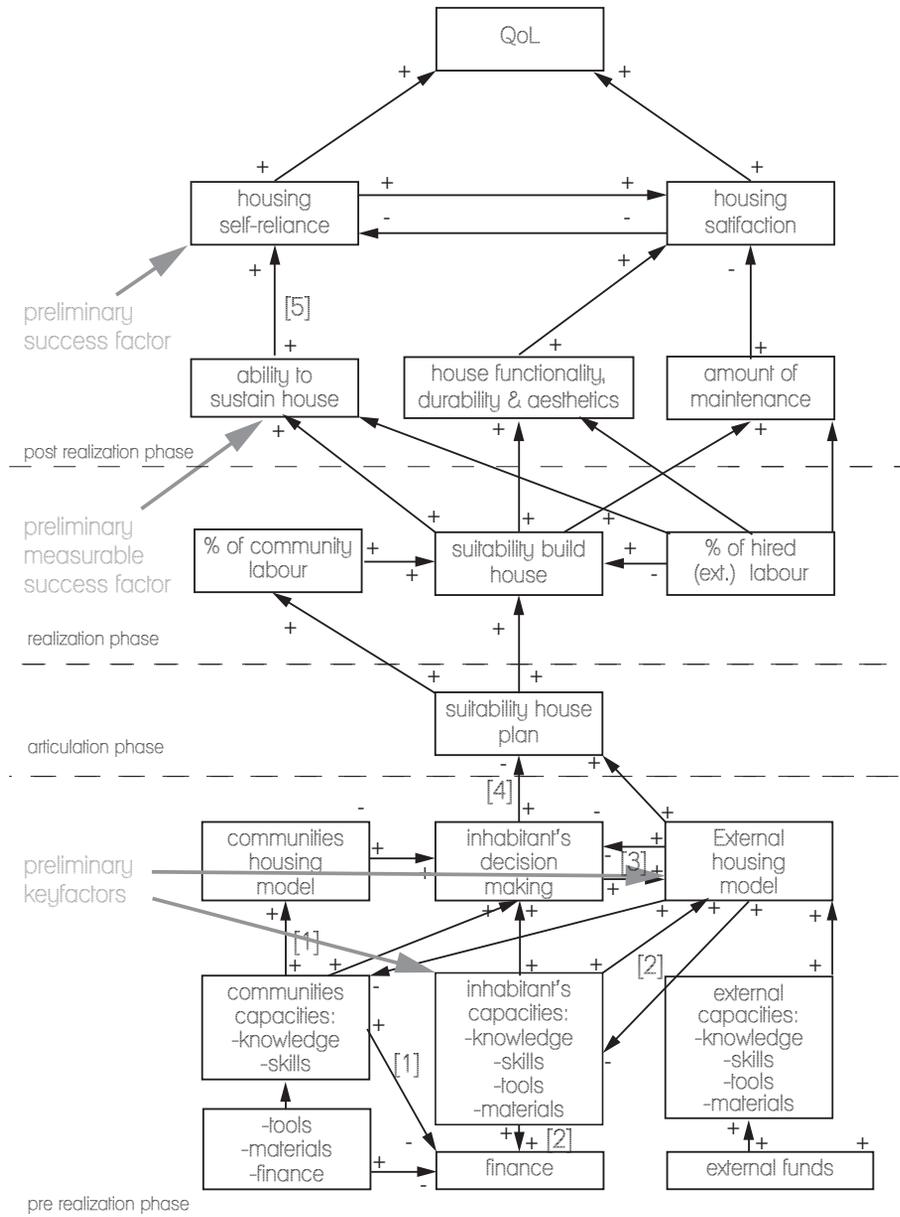


FIG. 5.13 Initial reference model (author, 2017)

These sections are repeated twice in the questionnaire once for the current housing and again for the desired housing, see: Appendix H. Enabling the confirmation of initial observations from the RC-Phase, in other words: if the selected families have comparable problems regarding their housing, to the families interviewed in the household survey. The questionnaire also contains the protocol and video/audio consent for the interview.

The same procedure is repeated at the end of the experiment. In this questionnaire (see: Appendix I & Appendix J) questions on the current house are repeated in the first section to reflect on their former house, which can then be compared with the answers given in the baseline-interview. In the second section, the family reflects on the built housing as a part of the experiment, enabling the comparison of past and introduced housing. Exposing to what extent the teams were able to improve to the families' self-reliance in relation to their housing.

To compare past and new housing in relation to the inhabitant's self-reliance, specific barriers identified in the RC-phase were used to articulate question themes and groups. These barriers relate to one or multiple factors of the reference model (see Figure 5.13). The most important targeted barriers and related factors are:

- **Suitability** Housing size: many families prefer expensive materials, often resulting in smaller housing, which can't house the entire family and increases the inhabitant's dependency on renting housing.
- **Inhabitant capacities & External housing model & External housing capacities** Rent & Landownership: In relation to variable 1, many families are forced to rent a house and land (Chepchoina or Famia) as they can't afford to build an improved house, increasing the inhabitant's financial reliance: no income = no habitation.
- **Inhabitant capacities** Availability, locality & costs of building materials: traditional houses were built from free/cheap materials that were locally available. Desired materials are expensive and not locally available. Building with them increases the inhabitant's financial reliance.
- **Inhabitant capacities** Self-built & Hired labour: family and community traditionally build their houses (without financial compensation) by themselves. As the desired materials (for example bricks) are more complicated to work with, families and communities need to hire skilled labour, which increases the inhabitant's financial reliance.
- **Inhabitant capacities** Building knowledge: If the inhabitants do not have the required building knowledge it increases their reliance to skilled labour.

- **Housing Self-reliance** Maintenance & permanence: An often-heard complaint is the level of maintenance of traditional housing. Modern housing⁶ in the inhabitant's perception does not require maintenance. However, even modern houses need maintenance, which increases the inhabitant's reliance to skilled labour.
- **Housing Self-reliance** Help & Alternative solutions: The traditional building evolved over centuries while modernity has shown inhabitants a giant leap in housing quality and durability. As a result, almost, the entire community desires a comparable style of 'modern' housing, although they lack the financial resources. This variable identifies the need of 'external help' in finding alternative solutions according to the inhabitant's capacities.
- **Housing Self-reliance** Capacity acceptance: When looking at the financial means inhabitants still prefer a housing solution that does not suit their capacities. An important additional variable indicates that if the inhabitant gained better understanding of their actual capacities and related building solutions (more realistic desires regarding their housing), then they are more likely to accept 'cheaper' alternatives.

In both interview-cycles (prior and after the experiment) one observer will have to be present to make sure all questions are addressed appropriately. Moreover, a social worker needs to make sure the interviewees are comfortable and translate any question if needed. None of the interview team-members are allowed to make suggestions or help inhabitants formulate answers. Additionally, the inhabitants in both cycles will receive separate consent-forms stating privacy issues and how the collected data will be used. Making sure that the interviewees know what the interview is for and how outcomes will be used after the experiment is finished. Now the impact evaluation framework of the applied support book in situ is formulated, another framework is required to evaluate the suitability of the Support Tool for the teams. This framework will be discussed in the next section, the outcomes of both evaluation frameworks will be presented in the next chapter.

RQ 8: How can the impact of the support be measured?

Answer: As elaborated, multiple groups measured the impact of the support. One strongly emphasizes the professional point of view. Here, the user of the support would reflect on the articulated housing solution and to what extent this solution contributes to the inhabitant's self-reliance. An external observer would be able to reflect on the social, cultural or spatial impact on the inhabitant. This research

⁶ Modern housing: inhabitant perspective on improved housing in comparison to vernacular housing tradition.

emphasizes strongly on inhabitant capacities and as these are deeply rooted in everyday usage and experience, the inhabitants are experience experts to reflect on the impact on them. Therefore, the user, although not a practitioner, reflects on their housing situation before and after the experiment in a structured interview setting. In the interviews, the questions are formulated around the identified research factors. As the inhabitants reflect on past, desired and new housing a comparison can be made in the inhabitant's level of self-reliance in relation to their housing. Effectively measuring the impact of the support on the new housing in comparison to their former housing.

5.7 RQ9: How can the suitability of the support be measured?

The previous section presented the experiment design, procedures and measurement of the support impact (inhabitant self-reliance regarding their housing). Focussing specifically on the impact of the tool on the inhabitant's self-reliance in relation to their housing. Comparing the level of self-reliance in their former and current housing (prior to the experiment) with that of their new housing (after the experiment). As the overall PhD research aims at articulating, testing and evaluating a concept version of a Support Tool for practitioners, the suitability of the support to them is equally important. Therefore, this section describes the framework in which the support's suitability is evaluated. Although inhabitants can formulate an opinion on the suitability of the support, they are not using the support themselves. Moreover, the Support Tool is written for practitioners due to the inhabitant's inability to articulate alternative housing solutions. Including their point of view would potentially present non-objective observations and are therefore discarded. For this reason, the evaluation framework focusses solely on the direct users which are the students and architects using the support in the quasi-experiment on Mt. Elgon. The evaluation framework consists of four parts:

- Page feedback
- Chapter feedback
- User survey
- User interview

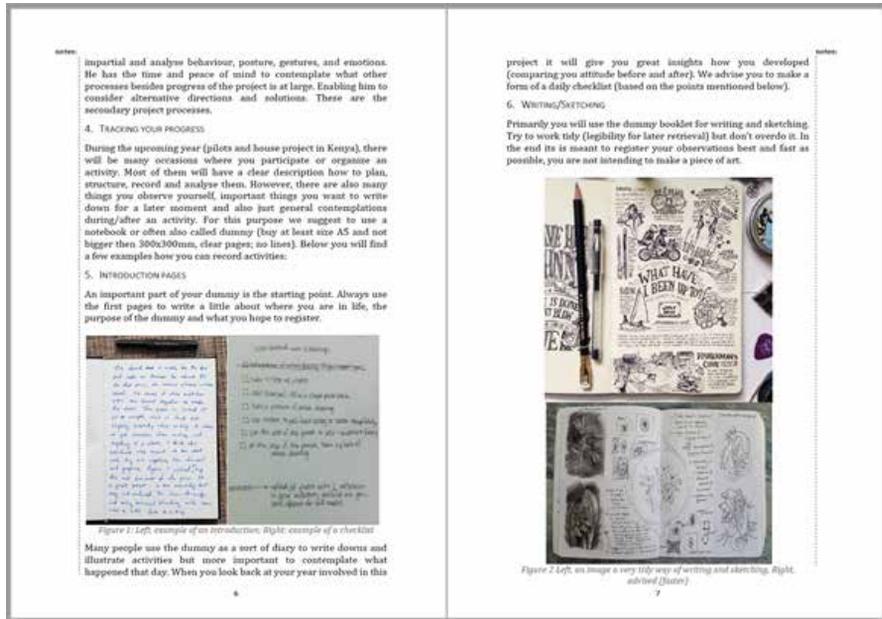


FIG. 5.14 Example page of the support book (author: M. Smits)

Operating the support already requires much from the teams, the evaluation framework needs to be easy to use in the field and requiring little time. Enabling the users to provide detailed feedback directly in the Support Tool. Therefore, the first part of the evaluation framework provides comment sections on the edges of the pages, see Figure 5.14. Not all the executed steps immediately lead to useful observations on the suitability of the tool. It often takes time and therefore, the second part of the feedback framework describes a section at the end of each chapter, see Figure 5.14. Both the page and chapter feedback can be used in understanding the usefulness of the individual chapter, moreover, which changes need to be made.

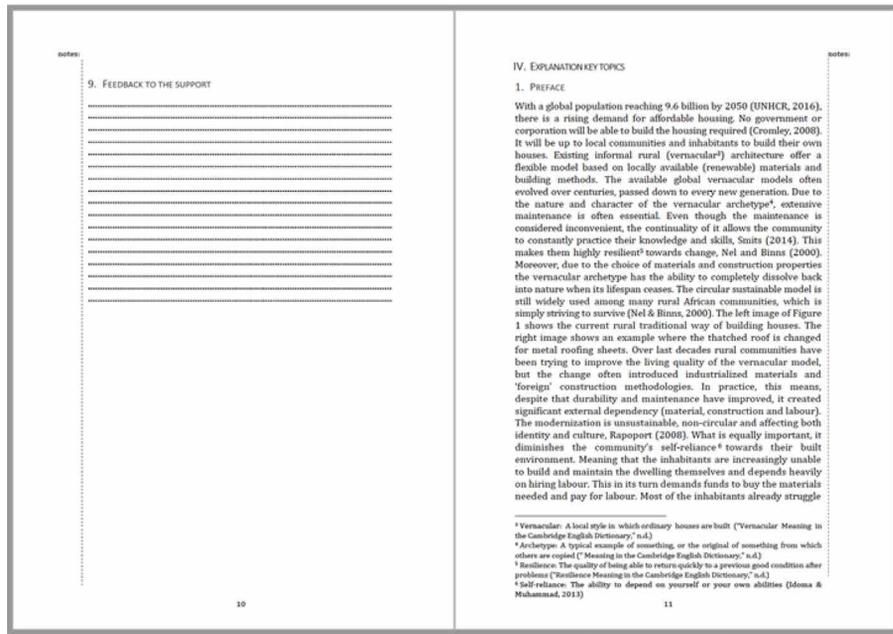


FIG. 5.15 End of the chapter feedback page of the support book (author: M. Smits)

To prevent any blind spots, the third part of the feedback framework entails an extensive survey (see: Appendix K) amongst the users. Questions included: usefulness per chapter (see page: 73-76), inhabitant capacities (see page: 80&86), knowledge exchange (see page: 84) and recommendation (see page: 87). The survey combines these questions with general ones on the design and experiences of the experiment.

In addition, in-depth interviews with the users of the support allow the author to address additional questions concerning the interviewee's responses (survey). In one-hour sessions the interviews are held with the users, giving detailed insights on the implications for executing the described support in situ. In half-hour sessions the teams reflect together on the project, the suitability of the support and possible recommendations. At the end of the experiment the books are collected and all the comments per chapter compiled to a feedback summary. These summaries are then combined with the survey and interview outcomes. Together they describe all the necessary adjustments to the support, which are presented in the next chapter.

RQ 9: How can the suitability of the support be evaluated

Answer: As the field experiment in Kenya (2017) is the first time the Support Tool is used; an elaborate evaluation is needed to assess its applicability and overall usefulness (suitability). Here users are not asked to evaluate the impact of the support on the inhabitants, but to reflect what supported them in articulating improved housing for their family. To enable the user to make remarks and suggestions in the field, comment sections were added. These can then be used to evaluate the suitability of individual chapters and lead to additions and alterations to the support. As the teams' time is very congested during the field experiment a second evaluation framework is needed after the experiment. In the survey the teams reflect on a detailed level on the support's suitability. In consecutive interviews the users reflect on the answers they gave. All outcomes Together can be used in a consecutive research where an improved version of the support can be tested.

5.8 Secondary Outcomes Prescriptive Study 1

The most important outcomes of this research are addressed in the answers of the identified research questions, in this section these were RQ5,6,7,8&9. This research also develops approaches, methods and tools which are tested and evaluated in practice. These identified criteria, experiment design, or practical tools (guides, instructions, etc.) are secondary outcomes which are useful for other researchers. The undertaken research steps are therefore valuable for their developed products (methods, frameworks, etc.) or as a case study for the produced data. This last section therefore addresses these practical outcomes

The previous chapter identified the key components of the Support Tool and pointed out that some of the components were missing. Sections 5.1, 5.2 & 5.3 therefore described how the missing components were developed for the Support Tool. The entire Support Tool can be found in Appendix E.

Section 5.6 addressed the design of the impact measurement of the Support Tool on Mt. Elgon. The section consisted of the following outcomes:

- Design of the experiment:
 - Convenience Sampling criteria: Participants (practitioners & Students)
 - Convenience Sampling criteria: Inhabitants
 - Sample size experiment
 - Design of team composition
 - Measuring for impact: division support groups and control group
 - Application procedure participants & inhabitants
 - Selection criteria & -procedure
- Approvals for experiment:
 - National and local government approval procedure (Kenya)
 - Academic approval procedure (partnership local universities)
 - Community approval procedure (regional & local)
 - Ethical approval procedure (TU Delft & Nacosti)
 - Appendix F: Informed consent procedure inhabitants
 - Appendix G: Audio/Visual consent procedure inhabitants
- Executing impact measurement:
 - Appendix H: Baseline measurement, interview guide (all groups)
 - Introduction
 - Questions on current housing
 - Questions on desired housing
 - Consent form
 - Appendix I: Impact measurement, interview guide (support groups)
 - Introduction
 - Questions on new housing
 - Questions on desired housing
 - Questions on the research project
 - Consentform
 - Appendix J: Impact measurement, interview guide (control group), same sections as

Section 5.7 addressed the design of the suitability measurement of the Support Tool on Mt. Elgon. The section consisted of the following outcomes:

- Feedback support:
 - Page feedback
 - Chapter feedback
 - Appendix K: Feedback Survey support groups
- Suitability recording (not formally part of the manuscript):
 - Daily Timelapse recording (one picture per minute while in the field)
 - Documentary team filming first and last two weeks of the experiment



6 Descriptive Study 2

The previous chapter described the Support Tool and the evaluation framework to measure the impact of the quasi-experiment. The current chapter demonstrates how the design support was tested on Mt. Elgon. In this quasi-experiment both professionals and students advised local inhabitants about accomplishing improved housing. The formulated evaluation cycle assesses the impact of the tool on the inhabitants' self-reliance, comparing their new housing situation with the former. Moreover, it analyses the suitability of the Support Tool for the involved practitioners and suggest possible additions and alternations to the support. The next chapter presents the reflection, conclusions and recommendations of this research.

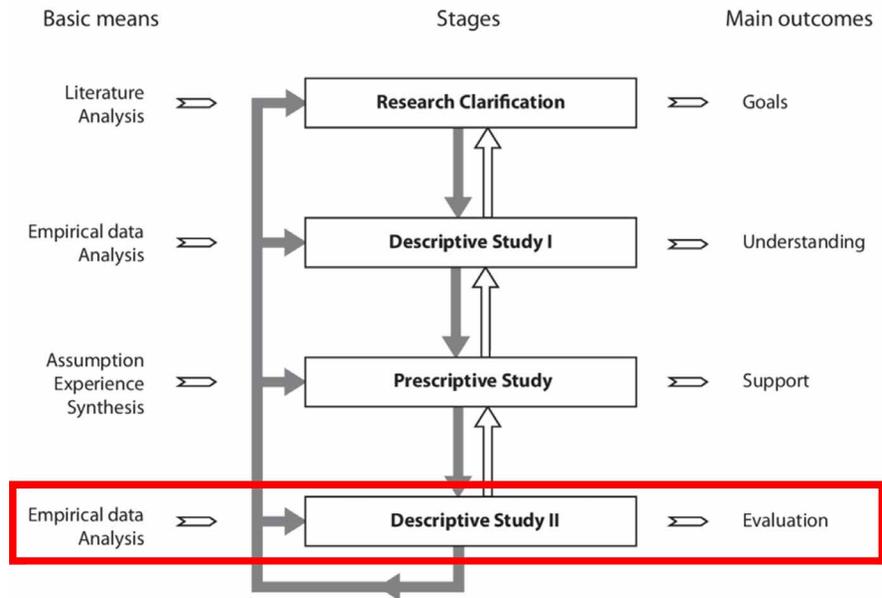


FIG. 6.1 DRM Framework (Blessing & Chakrabarti, 2009)

TABLE 6.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)		Goal
Research Clarification	RQ1	What are the main contributors to inhabitant's self-reliant housing?	Problem identification Hypotheses and Measurable Success Criteria
	RQ2	Are inhabitants able to articulate desired housing by themselves?	Addresses hypotheses 1,4,6 Answers RQ1+RQ2 Development of RQ3+RQ4
Descriptive Study 1	RQ3	Which factors hindered housing improvement?	Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4	What are the necessary key-components of the design support?	Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

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TABLE 6.1 DRM-stages with corresponding Research Questions and Goals

DRM Stage	Research Question(s)	Goal
Prescriptive Study 1	RQ5	What helps in approaching a vulnerable context? Goal A: Vulnerable context approach: Undesirable & desirable behaviour, appearance and communication Goal B: Vulnerable context methodology: Daily switching of actor & observer role
	RQ6	How can inhabitant capacities concerning their built environment be evaluated? Framework for inhabitant capacity evaluation: Mixed method (interviews, observations, games & context mapping)
	RQ7	How can inhabitant capacities regarding their built environment be integrated in solution formulation? Methodology for capacity informed decision-making.
	RQ8	How can the impact of the support be measured? Framework for impact measurable (success) criteria: - Baseline in-depth interviews with inhabitants - Impact in-depth interview with inhabitants and community members
	RQ9	How can the suitability of the support be evaluated? Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.
Descriptive Study 2	Test RC 1-9	Goal A: Evaluate support impact Goal B: Define the recommended adjustments to the support Verification of the Research Factors & Key-components
Conclusions		Verifications Hypotheses

Goals A&B are presented separately and therefore the chapter is divided into four sections. The first section (6.1) addresses Goal A, which evaluates the impact of the support on the articulated housing solution. The second section (6.2) addresses Goal B, evaluating the suitability of the Support Tool for its users (the practitioners) and the Support Tool adjustments they suggest. Section 6.3 verifies the research factors and key components. Section 6.4 provides with an overview of all answers to research questions. Section 6.5 presents the technological design of the Support Tool and section 6.6 the secondary research outcomes of this chapter.



6.1 Outcomes Goal A: Evaluating support impact: In-depth participant interviews

To better understand how the measurement of the support impact was designed the sections below explain: **who** was selected to measure the impact, **when** the measurements were taken, and **how**.

Who: Various parties would be able to reflect on the impact of the support in the articulated improved housing: the families, the research team, the support teams or external observers. The research-, support teams or an external observer could (physical result) reflect on the impact through their expertise. However, they would lack the local, cultural and social user experiences to provide sufficient broader understanding of the impact on everyday life living in the house. The majority of factors (housing satisfaction, ability to sustain house, etc.) can be best understood through the eyes of the families involved. Although they are not engineering or designing experts, they have in-depth understanding on the consequences on their everyday lives (comfort, finance, etc.). This understanding allows a research bias (hard to objectively look at one's own situation), however, it does enable an in-depth understanding of both physical as the social-cultural changes through the eyes of the family. Also, the technical evaluation and suitability of the new housing solutions are severely limited. The family has an elaborate understanding on traditional housing, however on new or alternative housing solutions is limited. Thus, it is of extreme importance that the impact measurement is considered within these limitations.

When: The evaluation cycle, to measure the impact of the support on realizing improved housing, consists of two parts. The first part is the baseline-measurement analysing the level of self-reliance in relation to the inhabitant's current housing. The second part is the actual impact measurement, analysing the inhabitant's level of self-reliance in relation to their new housing. The two parts combined will provide with the actual impact of the support on the housing situation.

Cycle 1, Baseline Measurement (housing before intervention): The current situation has to be analysed to understand existing living conditions and evaluate current housing satisfaction. Additionally, the families are asked which type of house they desire and why, enabling the families to reflect in depth on what is missing in their current housing and establishing expectations for their desired housing.

Cycle 2, Impact measurement (housing after Intervention): Having established a baseline measurement, the second cycle focusses on the new housing. Addressing, how the offered solutions have impacted the families' self-reliance regarding their housing. Post-occupancy theories recommend using the finished house as a starting point, furthermore, that the evaluation has to be repeated multiple times (years) for accuracy. Here, the inhabitant's ability to maintain, extend or reproduce the house can be physically observed and easily made comprehensible (survey, interview or observation). However, the means and timeframe of the research did not permit such an elaborate evaluation. The impact of the support had to be measured right at the end of the experiment (funds and time did not allow another measurement after completion), therefore allowing restricted insights in the actual suitability of the finished house and long-term impact. It is of extreme importance that the research impact is considered within these limitations.

How: As explained in the previous chapter, the identified measurable variables in the RC and DS1 phase concerning inhabitants' self-reliance, were used to formulate questions and captured in an in-depth baseline interview (see: Appendix I). This method for conducting interviews ensured that all questions were addressed appropriately (Creswell, 2013) and allowed inhabitants to provide with detailed and in-depth information (Guion et al., 2001). In the baseline interviews inhabitants received questions about their current and desired housing in order to better compare underlying motives for their current living situation and what they would like to change (desired housing). In the impact interview (post experiment) inhabitants got comparable questions about their new housing. As there were three teams with support and one team without support, two versions of the impact interview guides were made: Support Groups¹ (see: Appendix I), Control Group², (see: Appendix J), which enables the comparison of the impact between that of the support groups with that of the control group.

With this double interview cycle the situation before the experiment started (baseline: current and desired housing) can be compared with the situation after the experiment (impact: new housing). Moreover, it allows the comparison between impact of the teams with support (Support Groups) with the team operating without Support Tool (Control Group).

1 Support Groups: refers to the teams and the appointed families working with the support

2 Control Group: refers to the team and the family working without the support.

In both interview-cycles the social worker (G. Ngeyo) and the observer (B. Duda) were present. The social worker was present to make sure that the family was comfortable and offer assistance if any questions arose. G. Ngeyo was asked to participate because he was employed by local NGOs as a social worker and lived in the studied communities. The B. Duda (observer) made sure that both video and a separate audio recording were made during the interview. Moreover, she listed formulated answers to the questions and kept track if all questions were answered. B. Duda was asked to participate as she was also an architect, had experience in conducting interviews, and a proficient English speaker. This enabled her to formulate additional words or reformulate questions.

Conducting the interviews

The baseline interviews were conducted in August 2017 and the impact interviews in the period from December 2017 till January 2018. All interviews (ten in total) have been transcribed, however as explained above, only serve as additional recorded proof (besides video and audio recordings) of what transpired during the interviews. The observer sheets were used for the actual impact measurement. Here, the observer was able to capture immediate and detailed answers which exceeds the transcriptions: visual, audio, emotional and contextual (things that happened outside the scope of the camera). Triangulation of the transcriptions, video recordings, and the observer sheets would have increased accuracy of the outcomes. However, was not possible within the timeframe of this research.

In some of the interview's answers were given on a later moment, the interviewees adjusted their opinion during the interview, or sometimes contradicted themselves. Moreover, did the interviewees clearly showed behaviour that suggest untruthful answers or refused to answer. With someone present with an expertise in sociology or anthropology, severe improvements on the outcomes could have been made. However, was not possible within the budget and timeframe of this research.

It is also important to state that Family 11 redrawn from the project just after the construction phase started. The father caused dangerous situations that endangered the support team. After a problematic period, with multiple meetings and consulting the village elder, the family decided to quit the project. The next family (nr 4) on the original list was approached and after a thorough process they were added to the experiment. For this reason (which will be explained later on), family 11 is highlighted in the results. Therefore, two additional interviews were conducted on top of the original eight interviews.

Data analysis

A problem that emerged while transcribing the interviews was the lack of overlap between the interview questions and the identified factors of the impact model. Therefore, the interview questions had to be cross-referenced with the factors. The first step was to number factors (see: Table 8) and divide them into three categories: Community (C), Inhabitant (I) and External (E) factors.

TABLE 6.2 Current Reference Model including preliminary criteria.

I	C	Tools/Materials/Finance
II	I	Finance
III	E	External Funds
IV	C	Communities' capacities
V	I	Inhabitant's capacities: knowledge/skills/tools/materials
VI	E	External capacities: knowledge/skills/tools/materials
VII	C	Communities' housing model
VIII	I	Inhabitant's decision making
IX	E	External housing model
X	I	Suitability house plan
XI		Status
XII	C	% of community labour
XIII	I	Suitability of the built house
XIV	E	% of hired (external) labour
XV	I	Ability to sustain house
XVI	I	House functionality durability & Aesthetics
XVII	I	Amount of maintenance
XVIII	I	Housing self-reliance
XIX	I	Housing satisfaction

In two sessions the author and observer separately labelled all interview questions according to the listed factors. In a third session they presented the outcomes of their analysis and deliberated which factor seemed most appropriate. The outcomes of this session are presented in Appendix L. As a result, the questions were labelled according to the appropriate factor, however, the questions' interrelations remained unclear. To compare the differences between traditional, former and new housing, these interrelations needed to be identified. Therefore, the author and observer again separately labelled the questions and compared the results. Some questions were simply repeated in different sections of the interviews and were easily identified. However, some questions were related although differently formulated, the results can be found in Appendix M.

The baseline interview investigated the perspectives on current and desired housing, prior to the experiment. To retrieve an objective baseline measurement all the interviews were identical and conducted at the same time, the transcripts can be found in: Appendix M. The impact interviews were not identical as they needed to compare the outcomes between the control group and the support groups. The transcriptions of these interviews can be found in: Appendix N.

The outcomes are presented in the following subsections according to the project realization phases (pre-realization phase, articulation phase, realization phase & post-realization phase (see figure above):

- 1 Pre-Realization Phase (PRP)
 - a Inhabitant Capacities
 - b Community Capacities
 - c External Capacities
- 2 Solution Articulation phase (AP)
- 3 Realization phase (RP)
- 4 Post-realization Phase (PP)

Due to the number of interviews (ten), questions, factors and phases, a code was required. The code would clarify to the reader:

- The interviews: Baseline or Impact Interview
- Phase: Pre-Realization Phase, Articulation Phase, Realization Phase & Post-realization Phase
- Referred type of housing: Current, Desired or New
- Factors: nineteen factors (see: Table 8)
- Questions: question number

The observer sheets are available in Appendix O, divided in:

- O1: Baseline Interview, questions on current housing
- O2: Baseline Interview, questions on desired housing
- O3: Impact Interview, questions on new housing

To increase readability of the chapter the analysis and coding of this section is moved to the appendices. The coding of the transcription and their relation to the research findings can be found in: Appendix P.

Reading guide Goal A

To analyse the support impact on the investigated families, section 6.1 is structured in four phases (see: Figure 6.2): pre-realization phase, articulation phase, realization phase and post-realization phase. To understand how factors, relate to the main studied phenomenon (housing self-reliance) this section presents the outcomes from the bottom (pre-realization phase) upward. Due to the large number of factors and high complexity in the pre-realization phase this phase is divided in three parts. The rest of the phases are addressed per sub-section:

- 1 Pre-Realization Phase: Inhabitant capacities: factor II, V & VIII (section 6.1.1)
- 2 Pre-Realization Phase: Community capacities, Factor I, IV & VII (section 6.1.2)
- 3 Pre-Realization Phase: External capacities, Factor III, VI & IX (section 6.1.3)
- 4 Articulation Phase (section 6.1.4)
- 5 Realization Phase (section 6.1.5)
- 6 Post-realization Phase (section 6.1.6)

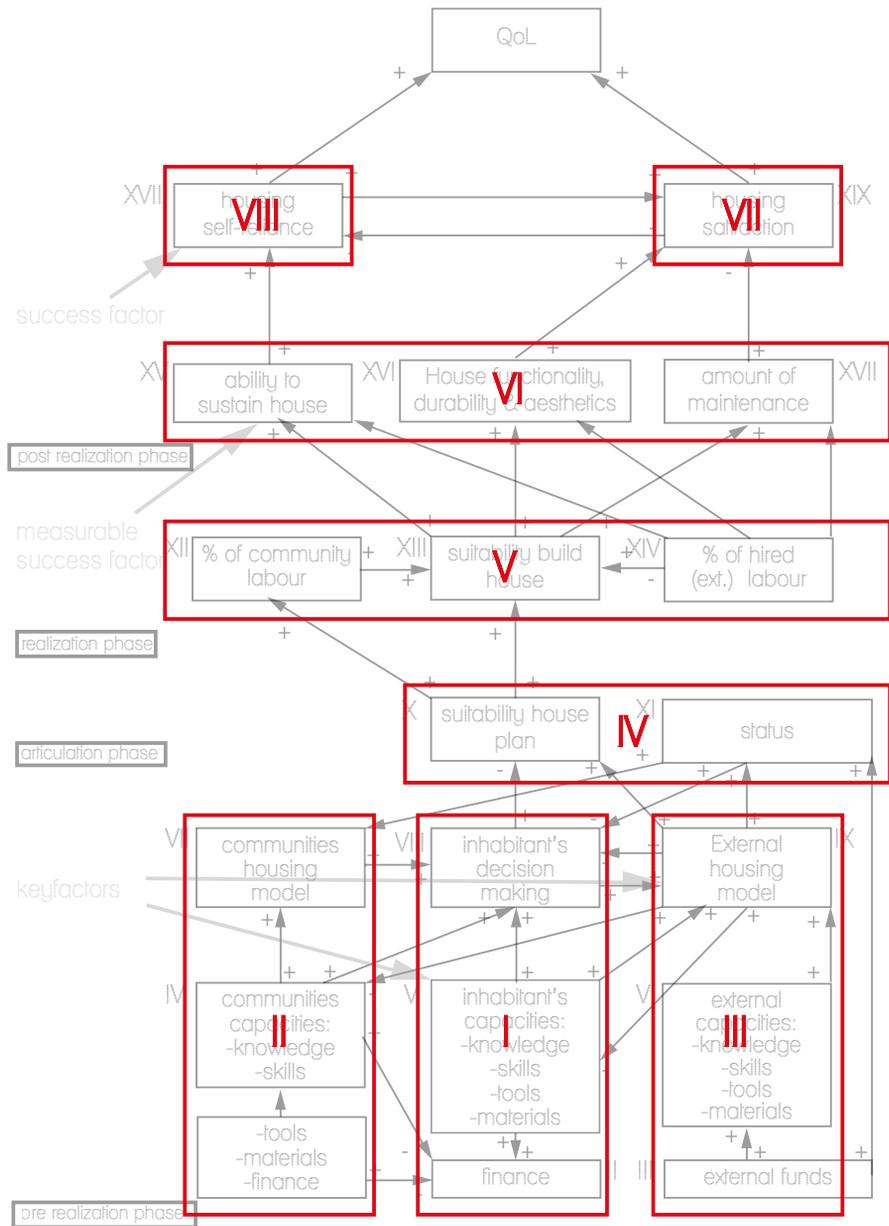


FIG. 6.2 Impact Model, inhabitant capacities

6.1.1 Pre-Realization Phase: Inhabitant capacities: factor II, V & VIII

As previously explained the post-realization phase consist of three parts: Inhabitant capacities (A), Community capacities (B) and External capacities (C).

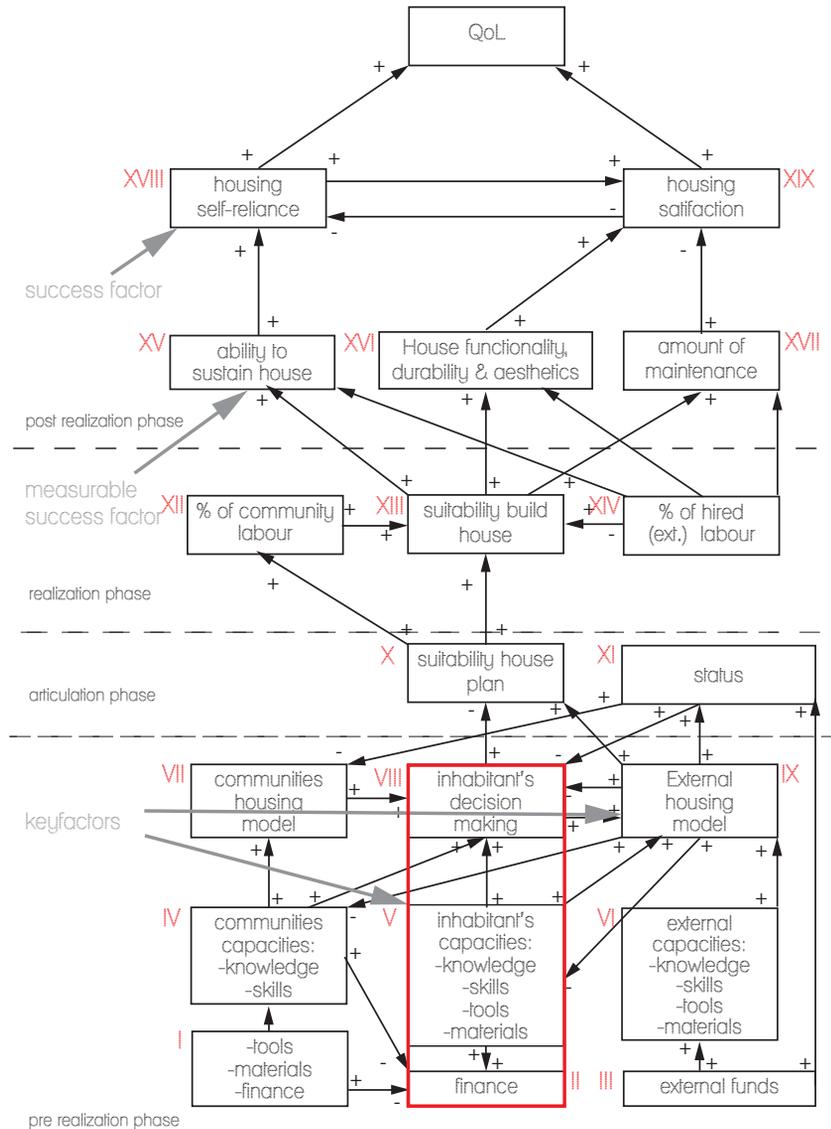


FIG. 6.3 Impact Model, inhabitant capacities

Currently, the families owned few tools themselves, most tools required for housing construction were borrowed or shared between families. Although tools are an intrinsic part of housing production this factor was difficult to assess within the interview. This does not mean that tools were not addressed in the Support Tool or not an intrinsic part of the new housing. However, due to the lack of usable answers, they are left out from this analysis. Many questions on skills were insufficiently answered and are due to their close relation to knowledge combined into: knowledge & skills.

Materials: Factor V

Current Housing: The Support Tool aimed at helping families which had local and free materials available, however answers about their current housing show that already in their current habitation the majority of materials were bought and required transportation (see Figure 6.4). Nonetheless, all families mainly (except in some cases: roofing sheets, cement and nails) used local and natural resources, consisting of soil, wood, grass, branches and cow dung. When asked if they would consider using these materials (ranging from very cheap to very expensive: Likert Scale), the non-manufactured natural materials³ were significantly cheaper than the manufactured non-natural materials⁴.

Desired Housing: Looking at their desired housing all families depict almost the exact same desired materialization: concrete, bricks/cement blocks, metal doors & windows, timber trusses, and iron sheet roofing (see Figure 6.4). They state that all are partially or not locally available, will need to be bought and would require hiring labour to gather. As all stated materials are manufactured and non-natural, they are considered significantly more expensive than the ones used in their current housing (which in various degrees have non-manufactured natural materials), average score: expensive. It shows that the families consider manufactured non-natural materials more expensive than non-manufactured natural materials. When asked if they would consider alternative materials that have similar characteristics but are cheaper than non-manufactured natural materials, all families said they would, although doubts arose if those exist.

³ Non-manufactured natural materials: are all natural materials which do not require an environmentally damaging manufacturing process and depend on available knowledge (inhabitant and/or community) and tools for application in housing construction.

⁴ Manufactured non-natural materials: are all natural/non-natural materials which require an environmentally damaging manufacturing process and depend on knowledge and tools which are not available (inhabitant and/or community) for application in housing construction.

New Housing: Looking at the materials applied in the new housing, the control group shows that almost all of them are comparable to desired housing (see Figure 6.4). The support groups applied natural materials to a various degree. Mainly in constructing walls: soil and sand. Although none of the support groups articulated housing solely with non-manufactured local materials, they applied significantly more of them than the control group. As observed earlier, the majority of both non-manufactured natural and manufactured non-natural materials are not locally available. However, the support groups did apply free materials, the control group had to pay for all materials. As a result, the support groups applied comparable or considerable cheaper materials than the control group.

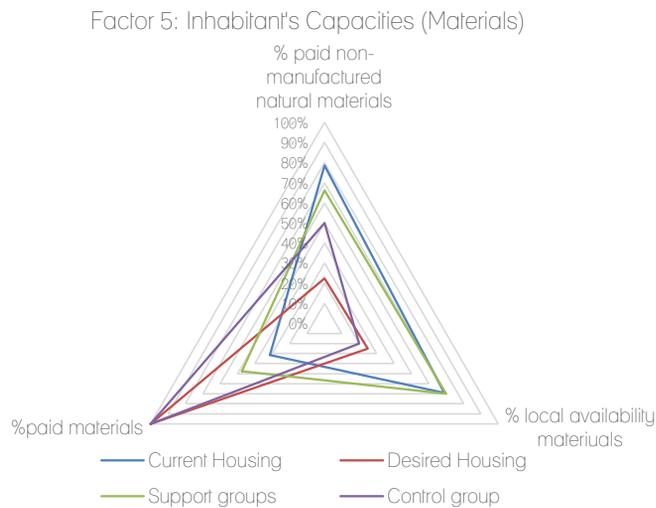


FIG. 6.4 Interview outcomes, inhabitant capacities, materials

Outcomes: Current housing shows that all families already used a substantial amount of manufactured non-natural materials. Yet, the majority was non-manufactured natural materials. Most of the materials required transportation (collected outside the community). The families indicated that they find the manufactured non-natural materials substantially more expensive than the non-manufactured natural materials. All families have a very similar desired housing, having mainly manufactured non-natural materials that will need to be paid for and would require hired transport.

They confirmed that they find these preferred materials to be expensive and that they would consider cheaper alternatives that have similar characteristics. The control group shows the most similarities between their desired and new housing. Moreover, applied comparable (to one other family) but in almost all cases significantly more expensive manufactured and non-natural materials.

The support groups applied considerably more non-manufactured natural materials that were often free, however none of the houses was entirely built from local materials. Even though natural, some of the materials did require transportation and therefore payment.

Knowledge & Skills: Factor V

Current Housing: In the current housing all families stated that they built the house partially or even in one case (family 11) entirely by themselves (see Figure 6.5). For specific parts of the house, where they lacked knowledge or skills, they hired a local builder to instruct the family, never though, to do the work for them but merely to offer the basis to perform the building activities by themselves. All families stated that they do not know how to completely build their current house without help; that this help/knowledge is not available for free in their community and that these issues are so complicated they require hiring labour. The majority of the families said that if they would have known how to build the parts, they lacked knowledge of, they would have built the house entirely by themselves. Consequently, they all stated that they need to gain external knowledge to enable them, however, when asked for which parts specifically, all families contradicted previously identified knowledge gaps. All families declared that they prefer to build a house they have sufficient knowledge of and therefore, prefer to build the house by themselves. When asked to what extent they are able to construct their current house by themselves, they answered: little (two families), able (two) and one very high. When asked which parts of the house they are able to repair, two families answered nearly everything, the other families can only repair the walls. The majority of the families know how to repair most of the house. Elements they would struggle most with are the roof, windows and doors. All families were taught to build this way by either family (father/parents), friends or neighbours/community. When asked if they would consider buildings methods closer to their building knowledge, they all stated yes. However, three of the families prefer materials that are not close to their existing knowledge and one identified that this is the reason why they need the external support. Although all families would prefer to learn how to build the house by themselves this is mainly to enable them to: maintain, extend or replicate the house in the future.

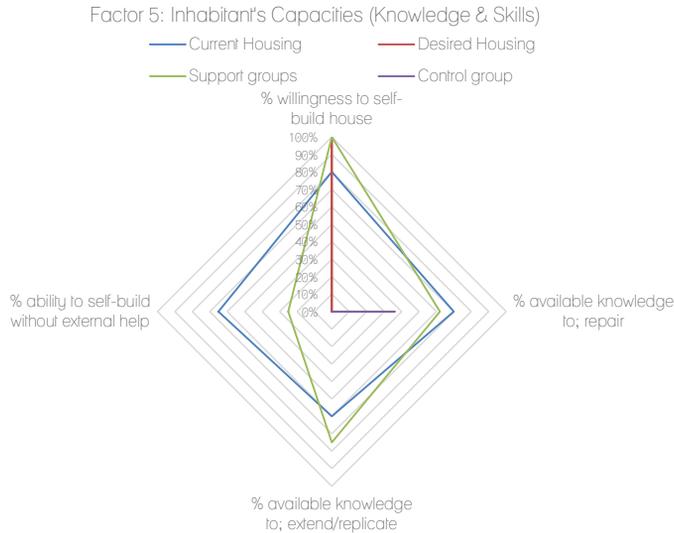


FIG. 6.5 Interview outcomes, inhabitant capacities, knowledge & skills

Desired Housing: When asked if the families would want to learn how to build/repair their desired housing, all families answered they would (see Figure 6.5). This contradicts their preference when asked if the families want to build this desired house by themselves. Here, two families (family 1 & 5) do not want to build the house by themselves. Family 1 also does not want to know how to build/maintain the house by themselves, while the other families do want to. The majority of the families (except family 1) would repair the house by themselves if they would know how to build/maintain the house.

New Housing: Three out of the five families say have the skills to finish the house by themselves (see Figure 6.5). As the project was abandoned during the construction of the foundation of family 11, it is understandable this family is unable to finish the house by themselves. **Family 5** (control group) also stated that they are unable to finish the house, which is odd since the house was the closest to completion. When asked if the teams offered the missing knowledge the answers were inconclusive. When asked to specify per building phase to what extent they have the knowledge to build the new house the support groups' families scored substantially higher than the control group. The highest score (4 out of 5) of the control group declared a high comprehension level of the foundation phase. However, considering the almost

complete absence of the family in this phase at the construction site, they either already had the knowledge (and did not participate) or did not answer truthfully (can also be seen in the transcription). When asked if the teams trained them to build this way all support group families agreed, where the control group disagreed. Three out of four support group families (family 11 most likely due to cancellation) agreed that they are able or almost able to extend or duplicate the house by themselves, where the control group is unable. In retrospect the families were asked if they would have realised the house without the team's help. The majority (4 out of 5) could not have built the house without the team. Again, family 11 said, they did not need the help (maybe only with making the plan and starting the building phase). The support groups did need the help and gave a variety of reasons why: motivation (family 1), new techniques: brick (family 8 & 4) and foundation: rocks without cement (family 8) and knowledge. The control group stated, they needed the team for the design and funding of the house.

Outcomes: The outcomes confirm that regarding their former housing⁵ the families were able to build most of the house by themselves, taught by family and community members. All families indicated that they have a moderate or advanced understanding of building and repairing their current house. Meaning that they know how to build the foundation, erect walls and roof construction, and fill in and finish walls. However, also show that they needed external hired labour for specific aspects, because they are too complicated. The help is thus to instruct the family in the process, enabling them to build the house by themselves (under supervision). This is indicating that the current improved building solutions lay outside the community's knowledge sphere. Access to this knowledge is not for free in the community. All families prefer to build the house entirely by themselves and need external support (reconfirming: hypothesis 1). When asked for which parts of the building process they need external help, they answer inconsistently with previously identified knowledge gaps, implying that: they struggle to specify exactly what external support they need. However, all parts of the house that they struggle with involve manufactured non-natural materials, revealing that they require external support as their preferred materials are not matching to their existing knowledge. The families prefer to build a house they have sufficient knowledge of, even though their desired house is not close to their existing knowledge. They all would consider materials and solutions that have comparable characteristics to their desired housing. They found the ability to maintain, extend or replicate the house, important for requesting external support.

⁵ Former housing: housing the family lived in prior to the experiment.

All families want to learn to build their desired house, however two of the families contradict themselves, they prefer to hire labour to build the house for them. However, prefer to learn how to build or maintain their house. Indicating that family 1 and **family 5** had a different preference in level of self-reliance in comparison to the other families before the start of the experiment. Although the majority wants to learn how to build their desired housing, which would enable them to repair the house (which they would perform by themselves).

The control group and family 11 stated that they are not able to finish the house, where the other families said they were. Although the answers of the support group families were inconclusive if the teams provided the missing knowledge, their stated knowledge levels per building phase are substantially higher in comparison to the control group. All support group families stated that they were trained to build the new house, which also shows in the families' high ability to extend or duplicate the house by themselves (except family 11 and the **control group**). The majority of families indicated that they needed the teams' support, confirming the need of external support (hypothesis 1). Moreover, while the support groups helped the families in a variety of solutions (material, construction, design, training, etc.) the control group only shared their design and funding.

Finance: Factor II

Current Housing: Although owning a house was a selection criterium, only three families owned the house and two rented (see Figure 6.6). The families, which owned their house, financed it through savings. To better understand what the families would consider expensive in their housing, they were asked how much the roofing sheets cost (one of the most expensive manufactured non-natural materials in current housing) and if they considered them expensive. Although prices for the roofing sheets did fluctuate (300-500 KSh. Per sheet), most of the families perceived them to be expensive (three families) and one moderate. In the follow-up question the families were asked to state per material to what extent they perceive them to be expensive. Family 11 stated that everything except a part of the roofing (wooden spacers) was entirely free. However, the other families had to buy some of the materials and were considerably more expensive. Again, the manufactured non-natural materials are perceived as the most expensive. The entire housing realization costs were initially estimated on: 40.000 (family 8), 120.000 (family 1), 80.000 (family 4) and 36.000 KSh (**family 5**). Of the two families that did answer, they both indicated that they would not be able to afford to hire somebody to perform the repairs on the house in case they would lose their income.

Desired Housing: The two families that preferred to hire labour to realize their desired housing answered that they have insufficient funds to buy materials and hire labour (see Figure 6.6). The materials listed for the desired housing are considerably more expensive than the current housing. When asked if the families can currently finance their desired housing, three out of five stated they could not. The two families that can afford their desired housing declared to have sufficient savings to do so. This raises the question why the families applied for the project in the first place, although this was unknown at the time of the selection. At the time the interview was conducted, the answers given by these two families were considered as a possible misunderstanding. In retrospect one of these families was excluded from the project and the other complicated the building phase by changing materials (explained at the new housing section).

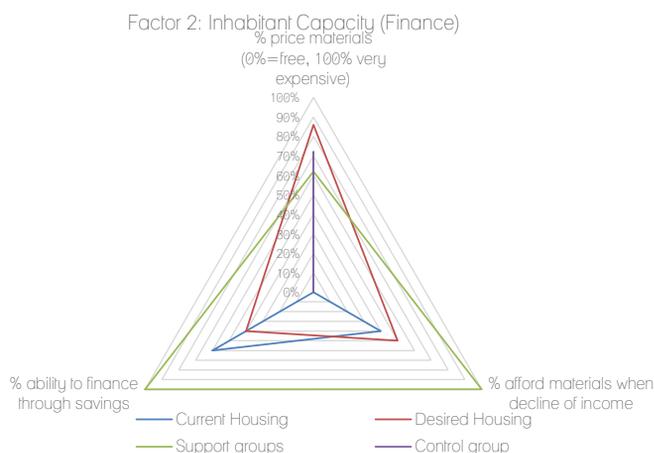


FIG. 6.6 Interview outcomes, inhabitant capacities, finance

Income: Originally the families' income and assets were excluded from the interviews (see Figure 6.6). However, proved to be important to comprehend the financial capacities between the current and new housing. All families stated that they have an income, own a land where they grow crops which (mainly) generates an income or is used to feed their family. Most of the families stated that their income fluctuates seasonally, only one family has a stable income. The income ranges between 5.000 to 30.000 Ksh during harvest, however, can drop between 3.000 to 15.000 Ksh.

New Housing: The majority of the families spent money on materials and labour which were not budgeted by the team (see Figure 6.6). When asked if the families have the means to finish the house all support groups stated they do, while the control group stated they don't. The same applied for financing the house, only the control group used a loan to build the house (provided by their employer) support by a large sum from their team (donation: 200.000,- KSh), the other families all used their own savings. The control group family stated that their team financed almost all costs involved to realize their house. Some materials were similar between all the houses (cement, sand, ballast, etc.) which all were consistently stated as expensive by all families. However, the level of expenses involved in the control group are considerably higher than those of the other groups. It is important to mention that many of the support teams were unable to convince families to use more non-manufactured natural materials. In two support groups the families largely discarded the solutions of their team and replaced them with manufactured non-natural materials. All support group families can pay for repairs in the case they would lose their income, which contradicts the control group, that does not think they would be able. When looking at the total sum of the cost of the new houses the differences are quite staggering (might be due to the unclear amount of savings):

- Family 8: 57.000–67.000 KSh (declared income: 15.000 KSh), 4-5 months wages
- Family 11: 300.000–400.000 KSh (declared income: 5.000 KSh), 60-80 months wages
- Family 1: 450.000 KSh (declared income: 30.000 KSh), 15 months wages
- Family 4: 200.000 KSh (declared income: 15.000 KSh), 13 months wages
- Family 5: 310.000 KSh (declared income: 4.000 KSh), 77,5 months wages

The summary above shows that the family 11 and the control group (family 5) have the most extreme income to investment ratio. The support groups have around a year's worth of wages invested in their new housing, showing a significant difference.

Outcomes: The families that own their current house financed them through savings. Although family 8 almost build the entire house for free (excluding: transport and hiring some labour), the majority had to pay for most materials. Many non-manufactured natural materials were not available in the community anymore and consequently required hired labour and transport. The entire costs for their current housing of all the families, was ranged between 35.000-120.000 KSh. Surprisingly the families that answered (two) they cannot afford repairs to the house if they would lose their income.

Two families can't afford to hire labour to build their desired house, however, would prefer to hire labour. All desired materials are substantially more expensive than those of the current housing. Based on these material choices the majority (three) of

the families does not think they can afford them. The two other families stated that they can afford the desired housing, which raises the question why they applied for the experiment.

All the families have an income and own a plot where they grow crops for income or to feed the family. Besides the yield the majority of the families stated that their incomes fluctuate, range between 5.000-30.000 KSh and seasonally drop to 3.000-15.000 KSh. This makes the families vulnerable to additional costs

The outcomes show that all families had to make additional costs (materials and labour) which were not estimated by their team. However, all support group families state that they are able to finish the house based on their savings. The control group, which was also the only family relying on external funds mainly offered by their team, is not able to finish the house by themselves. A considerable amount of non-local materials was used by all teams (most support groups were not able to convince families to their material propositions), which they all considered expensive. However, the control group applied considerably more expensive materials than the support groups. It was also the control group who stated that they are no able to pay for house repairs, which can be explained by the considerable investment that needs to be made to build the house (6,5 years wages). It is only topped by family 11 (7 years wages), yet the other support group families all required approximately 0,5-1,5 years wages.

Therefore, the outcomes indicate that the teams operating with the support were able to articulate solutions for their families that they are able to finish by themselves. Despite having unforeseen costs, the families with support all used available funds (savings) and are able to maintain their house.

Inhabitant Decision-making: Factor VIII

Current Housing: Current housing shows that the family already used manufactured non-natural materials and for example consider iron sheets to be expensive (see Figure 6.7). However, the families struggle to list cheaper alternatives. In spite of easily listing the negative characteristics of roofing sheets, they still prefer them as they are aesthetically pleasing, fire resistant or easier to get. They are aware that manufactured non-natural materials are more expensive and require more skilled/hired labour. All families would have preferred to build their house differently, with more desired materials, however that they lacked the funds to do so. Although they do consider alternative cheaper materials with similar characteristics, which are closer to their existing building knowledge and would have enabled them to replicate or maintain their house in the future.

Desired Housing: The families desired to apply more external materials; although they know they are expensive and would require substantial external knowledge; they think that they would be able to learn required skills in three months' time (see Figure 6.7). However, the majority would prefer to build the house by themselves and would consider alternative/cheaper materials/methods that have the same characteristics. Moreover, confirming that there is a high willingness to help construct a community building or house, in order for them to learn to build their house.

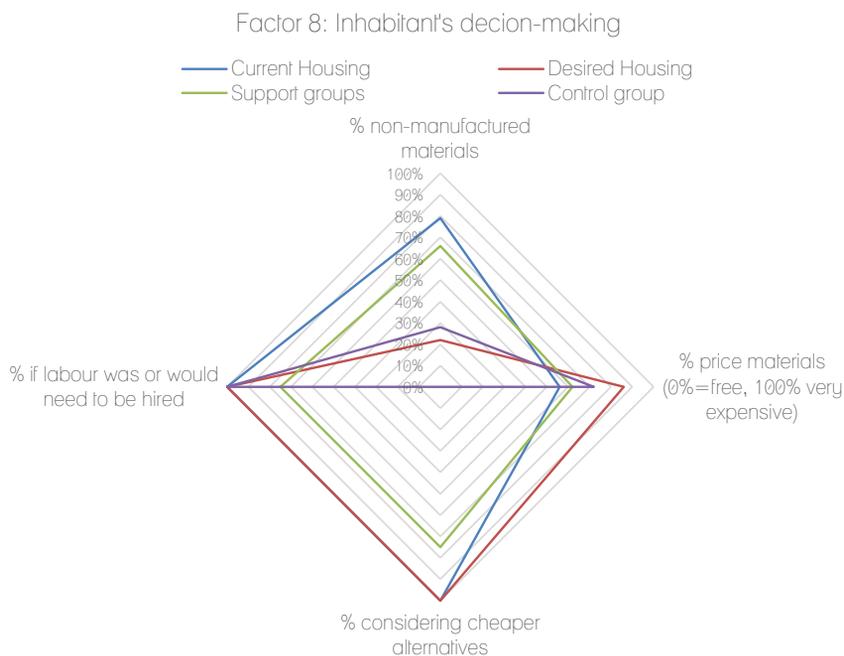


FIG. 6.7 Interview outcomes, inhabitant capacities, decision-making

New housing: As mentioned before the control group used substantially more manufactured non-natural materials and external knowledge to construct their new house (see Figure 6.7). However, the support group families did use more manufactured non-natural materials than intended by the support or their team. As explained at factor II, this was mainly related to differences in financial capacities of the families. Here, the families (11 & 1) with higher financial capacities used more manufactured non-natural materials than the families with lower financial capacities (family 8 & 4). Moreover, families 11 & 1 changed the materials, originally planned by their teams (as stated by the teams in the end interviews), with non-manufactured

natural to manufactured non-natural materials. This contradicts the families' statements on who made material decisions: which were said to be made jointly between family and team. The support relied heavily on community participation to exchange knowledge and helping the families for free. In the new housing, community members would benefit from the families they helped in order for them to realize improved housing as well. However, this was impossible according to the families and any community member helping, in their opinion, has to be financially compensated. Even though the interview insufficiently addressed these issues, they are discussed in the support feedback (see next section: 6.1) and end interviews with the teams.

Outcomes: The answers given concerning decision-making processes were sometimes contradicting and it was difficult to uncover families' true opinion. However, they have clear ideas which materials they desire, that these are not affordable (also in their application), they are willing to consider cheaper alternatives with similar characteristics. Although they do not know which alternatives there are and that they require external support to advise them. Using past (local) non-manufactured natural materials and similar techniques, do not meet the desires of the families. Decisions made by the support teams are often not fully understood by their families and are therefore rejected. The families 1, 11 & 5 were leading in the decision-making process which allowed more external materials than originally planned.

The experiment also showed that due to the limited practical experience of the teams, the families conveyed with local engineers (fundis). These engineers had no schooling, however often much experience. As a result, they advised the families to reject suggested solutions of their team and apply external materials.

Recommendation: In presenting alternative materials, the family's desired materials need to be used as departure point. The families expressed such a high desire for modern housing and materials, that presenting traditional solutions by practitioners would meet tremendous resistance. If a practitioner aims at introducing a new technology or material, it is advised to first build a mock-up or part of the solutions. In this way the inhabitants can see and test the solution by themselves and is crucial for the adoption of the solution by the family.

6.1.2 Pre-Realization Phase: Community capacities, Factor I, IV & VII

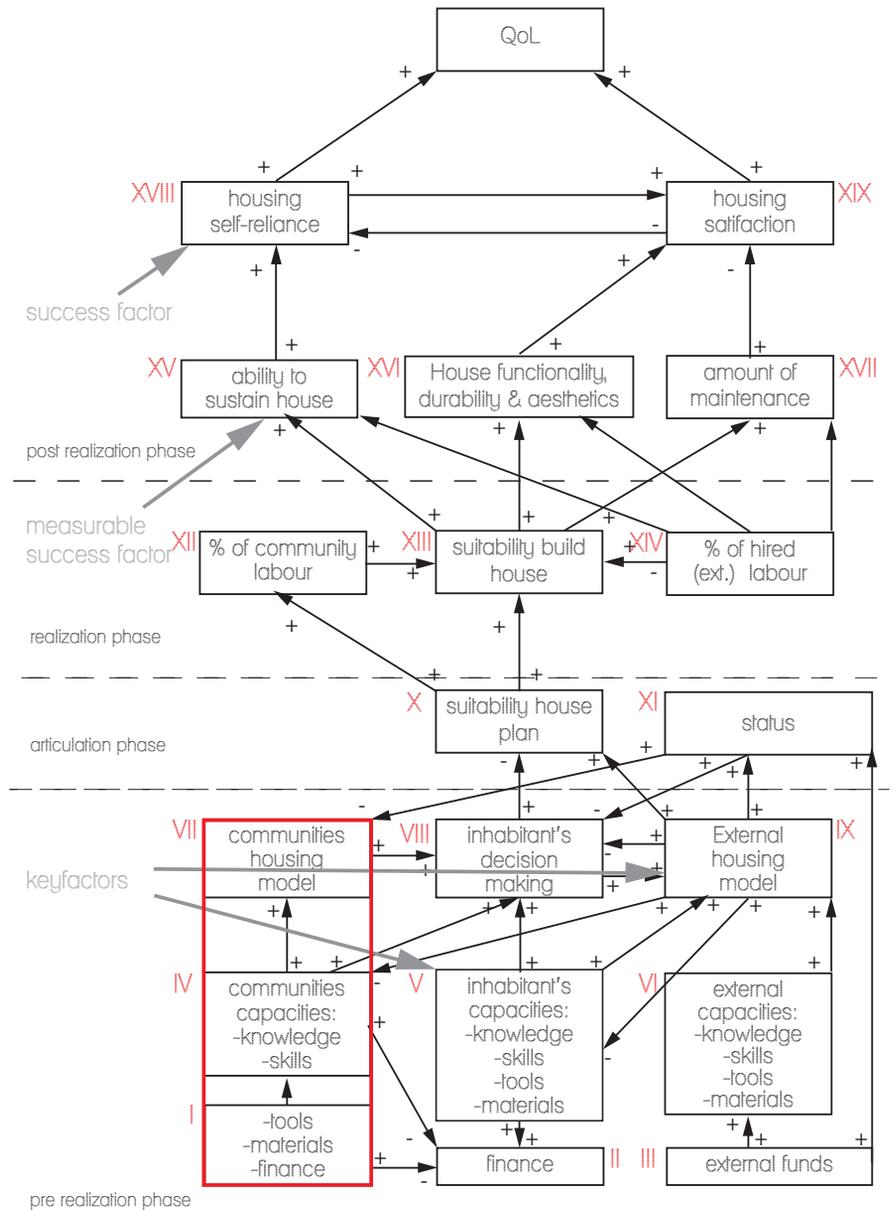


FIG. 6.8 Impact Model, community capacities

None of the community members were interviewed, therefore the findings on the community's capacities needs to be perceived through the eyes of the families which participated in the interviews. None of the interview questions addressed the topics finance and tools these topics are therefore removed from this section. Like the inhabitant capacities the topics knowledge and skills are merged in one topic.

Materials: Factor I

Current Housing: Although answers differentiated strongly, many of the non-manufactured natural materials are locally available, where manufactured non-natural materials are not. In other words, non-manufactured natural materials are either available within the community or adjoining communities. Manufactured non-natural materials require transport which is mainly hired (and paid). The majority of the materials are bought, only one family was able to build the house almost for free.

Desired Housing: The majority of the families prefer materials for desired housing which are either not locally or only few available. All families would need to pay for the materials and would require hiring someone to transport them.

New housing: All support group families, applied locally available materials. Indicating that not only transport costs were possibly reduced, but that also the majority of materials come from within the community or adjoining communities. The control group family stated that only the timber was locally bought, and the rest of the materials were all from outside the community. The control group bought all materials; the support groups used multiple materials, which were locally collected or available.

Knowledge & Skills: Factor IV

Current Housing: Although the support considered the community to still largely depend on building houses communally, the Baseline interview proved the contrary (see Figure 6.9). All families built their current housing mainly by themselves, in some case supported by an engineer or community member. However, when asked from who they received help, they stated that this was received from their community members (which might be a misunderstanding as a fundi could have been considered a community member). The families that did state they received help from the community, said it was either small or focussed on a particular component and was generally unskilled labour. The majority of the families has helped other community members to build their house in the past. Most of the families that did receive help

(mainly in form of digging) from community members did not help them in return. As mentioned before, families do not have the knowledge to build desired housing by themselves. When asked all families answered that there are no community members that are able to teach them for free.

Desired Housing: Only two families would prefer to build desired housing by themselves and their community, the rest prefers to hire labour (see Figure 6.9). Also, only two families believe that the community has sufficient knowledge to build desired housing.

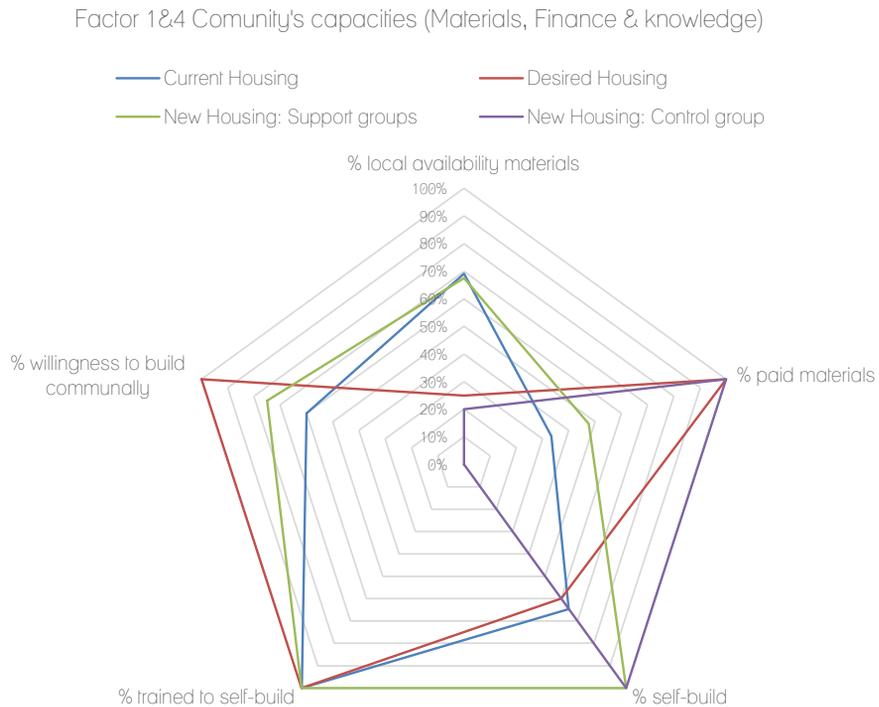


FIG. 6.9 Interview outcomes, community capacities, materials/finance & knowledge

New housing: Almost all help the families received in constructing new housing was from their own families or neighbours (see Figure 6.9). Involved community members mainly helped in unskilled labour activities and were compensated. The majority of the families perceive this to be substantial help. This is however contradicted by the teams (end interviews). The support group families are able, and the control will

not be able to extend or replicate the house by themselves or with the help of their community members.

Outcomes: Even though limited, there still was some level of community participation. The majority of the support group families believe that the articulated housing solutions enabled them to extend or replicate the house by themselves and with the help of their community, indicating that the support groups did accomplish to transfer capacities to the families and some to their community. The control group did not have any community support and does not think they able to extend or replicate the house by themselves or with the support of their community.

The majority of non-manufactured natural materials are available within the community or adjoining communities. Manufactured non-natural materials require transport which is mainly hired and needs to be paid for (labour and transportation). However, the majority of all materials used by the families in the experiment are bought.

The majority of materials for desired housing are not locally available, are paid and require hired labour and transport.

The control group paid to get most materials from outside the community, while the support group families got many locally and in some cases for free. This shows that the majority of the materials these teams (except control group) bought and/or transported locally, potentially contributing to the community's economy.

Community housing model: Factor VII

Current Housing: All families think that they were trained to build their current housing with their family, neighbours or community members (see Figure 6.10). As a result, they are able to repair the house by themselves, indicating that there was commonly known housing model in which the community shared the knowledge that enabled families to build their current housing.

Desired Housing: The majority of families had doubts if neighbours, community- or family members would help them to construct their desired housing (see Figure 6.10). As mentioned before the families do not think the desired building knowledge is available for free within their own community. They however think that the training in desired building methods and materials would be possible to complete within three months, which is also reflected in their (declared) high willingness to learn how to build by themselves, help realize housing for other community members in order to learn, or even through realizing a public building.

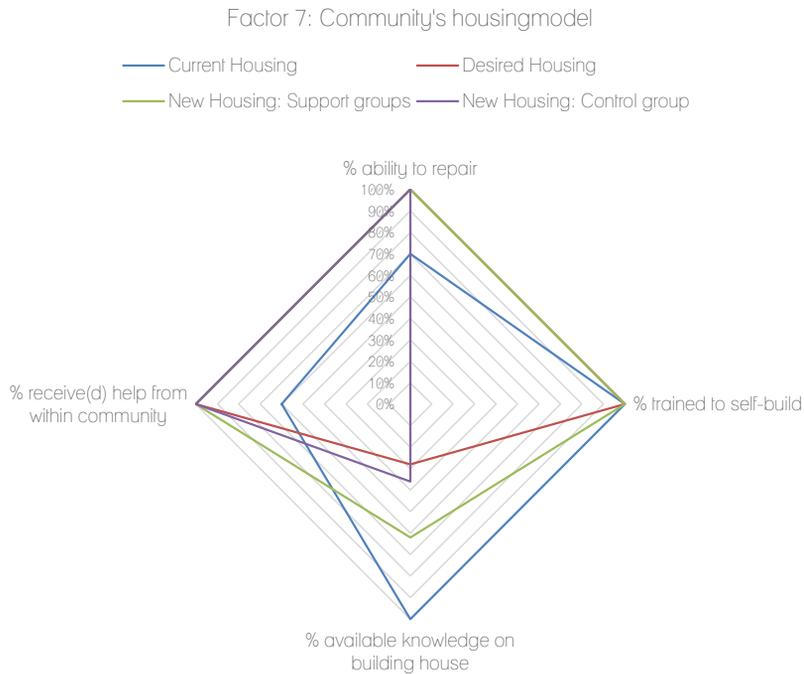


FIG. 6.10 Interview outcomes, community capacities, housing model

New housing: When asked who decided to build this type of house, the support group families stated that they decided on the housing solution together, also expressed in the selection process of materials (see Figure 6.10). The exact opposite can be observed in the control group and family 11, here the families made all the decisions by themselves. The knowledge gained by the families is of vital importance for sharing possible new housing solutions. Here, the control group scored substantially lower than the other groups. Moreover, the support groups trained the families to build their new house, while the control group did not.

Outcomes: The support intended to realize improved housing as close as possible to the current capacities of the families. However, the experiment shows that the families preferred desired (modern) housing, even if these do not meet their existing capacities. Moreover, the family and community participation during the construction was lower than expected. These are the main reasons that the knowledge transfer on the new housing solutions was lower than expected, leading to a limited improvement to the community's housing model.

6.1.3 Pre-Realization Phase: External capacities, Factor III, VI & IX

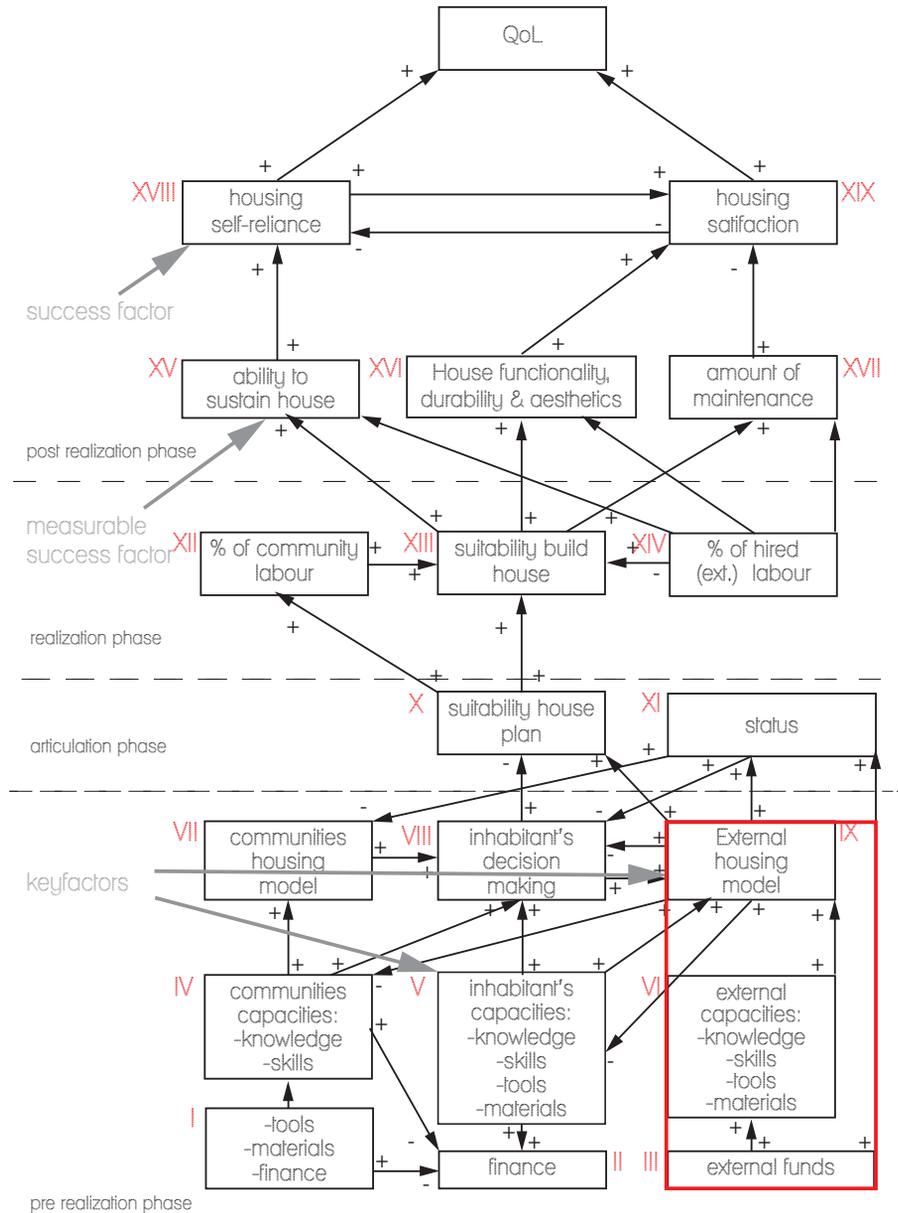


FIG. 6.11 Impact Model, inhabitant capacities

Finance: Factor III

Current Housing: As stated before the families financed their current housing mainly through savings, although two families are currently renting, suggesting that currently there is already a need for externally initiated housing provision in the community (see Figure 6.12). Here, the houses are financed by people from within and outside community. This renting system makes the families extremely financially vulnerable (fluctuating income endangers the ability to sustain housing).

Desired Housing: The majority of the families do not think they are able to finance their desired housing (see Figure 6.12). This can be explained by the estimated higher material costs, increased need to hire labour and transportation. In the case the families are helped by an NGO the majority expects that they would still require help after the project is finished.

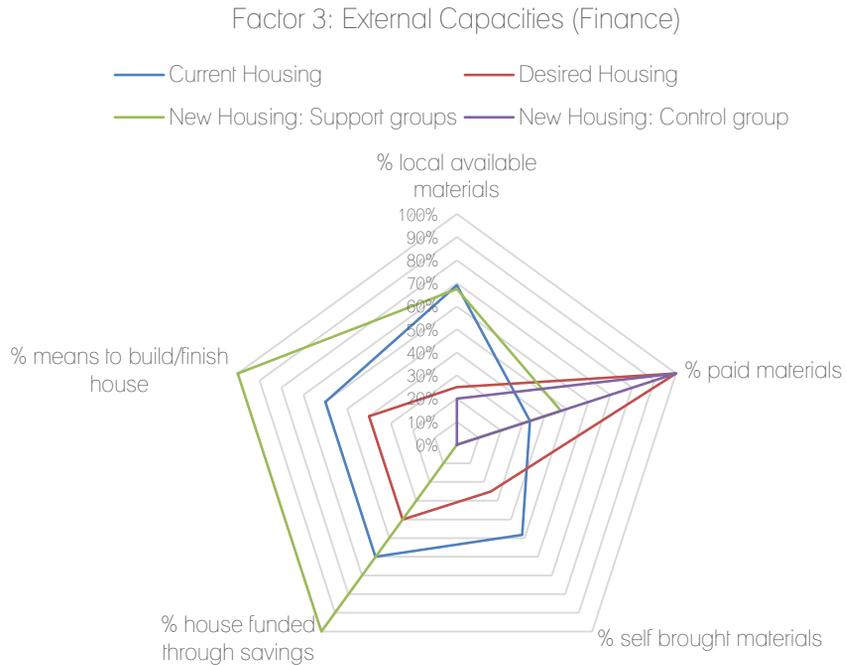


FIG. 6.12 Interview outcomes, external capacities, finance

New Housing: The control group does not have the means to finish the house, which is the opposite in the case of the support group families, who all stated that they have the sufficient means, even though all families think that they will need to hire labour (see Figure 6.12). The control group bought all materials, while the support groups applied various amounts of cheap and/or non-manufactured natural materials. The control group used a loan to finance the house, which is only partially true. Their team donated approximately 200.000 KSh into the project (65% of the total sum). The loan the family took came from their employer to finance the rest of the required funds. The support group families all used their savings to build the new house, deploying existing financial capacities. When looking at the previously stated financial capacities of the families, it is highly unlikely if the control group would have been able to build this type of house using existing financial capacities. It is important to mention that the control group team stated in their end interview that their main regret was to finance the project. The most important motive was the lack of the family's involvement.

Outcomes: The results indicate that the families had a higher financial dependency (external materials and hiring skilled labour) than originally assumed. In their current housing many of the materials have to be bought and transported. Comparing these to the desired house there is a sharp incline in the amount of manufactured materials they will need to buy, that need to be transported and require hired engineers to apply. When looking at the impact of the experiment, the control group applied mainly external materials, knowledge and funding.

Materials: Factor VI

Current Housing: As previously argued inhabitants already depended severely on external materials (community and inhabitant capacities). Moreover, many of the materials in their current housing are manufactured non-natural materials, which are bought and require hired labour for transport (see Figure 6.13).

Desired Housing: In the desired housing all families stated comparable materials, which shows an extreme incline in materials and knowledge from outside their community (see Figure 6.13). It's confirming that some of the materials are locally available, however a considerable amount comes from outside their community, and the majority will need to be bought and transport will need to be hired.

New housing: The Support Tool aimed at lowering the amount of manufactured non-natural materials as much as possible (see Figure 6.13). Even though the support groups did use manufactured non-natural materials, the amounts are considerably

lower than the control group. These support groups got various materials locally or even had them on their plot. Only family 11 had the same amount of transported materials (except timber) in comparison to the control group.

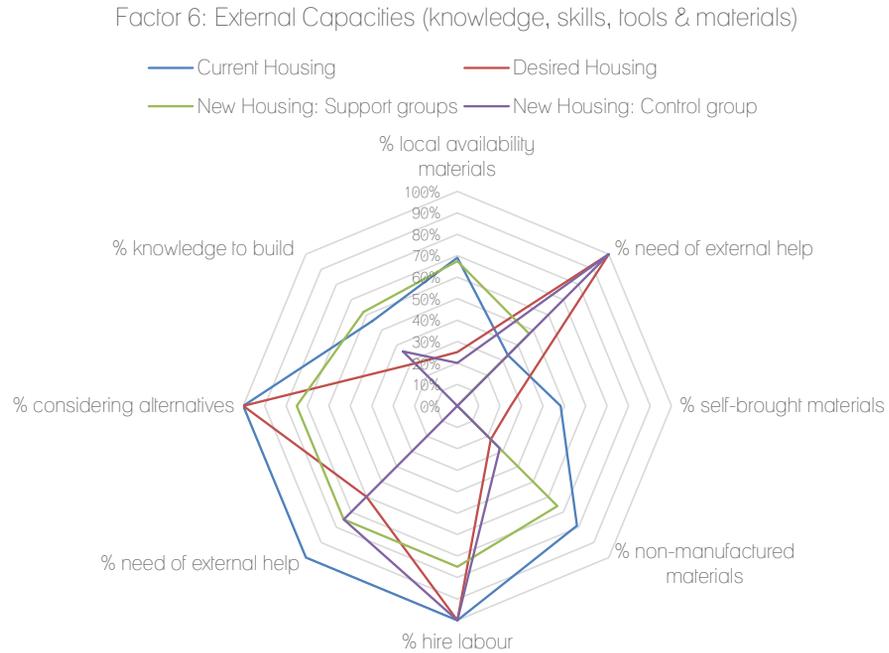


FIG. 6.13 Interview outcomes, external capacities, knowledge/skills/tools & materials

Outcomes: Although the support intended to mainly use local and non-manufactured materials, it proved that these were already often applied in their current living situation. The teams with support, on the other hand were able to keep the amount of external materials comparable to the current housing. The control group shows that they used almost solely external materials, which is confirmed by the majority of the support group families. Only family 8 almost entirely followed the initial plan, this mainly due to the financial constraints.

Knowledge & Skills: Factor VI

Current Housing: The majority of families hired labour to construct some parts of their current housing. Mainly due to the lack of skills/knowledge to do it by themselves. The main reason for not building desired housing by themselves was

due to the complexity and therefore there was a need to hire an engineer. However, if offered, they would consider a building method that is closer to their current building knowledge.

Desired Housing: All families answered that they do not know how to build their desired housing and due to the level of complication depend on external (hired) engineers to build it for them.

New housing: All support groups have taught the community members new skills. The control group only had their own family participating during construction and therefore community members were not taught any new skills. The same counted for the external knowledge transfer between the teams and the families, here only the control group thinks that they were not trained by the team to build the new house by themselves. It was again family 11 & **family 5** that solely hired external labour, where the support groups only partially hired labour, which was mainly unskilled indicating that the control group depends more on external knowledge. Comparing the knowledge levels between current, desired, and new housing reveals the following: the support groups families have a comparable/improved knowledge about building of their current and new housing. In comparison to the desired housing (required mostly hired knowledge and skills) the success is even greater, where the families expected not to be able to extend or replicate the house without external knowledge. Moreover, the majority of support group families think that they needed the external support of their teams to offer: new techniques, materials and building components. They were also necessary to motivate the families to take the initiative. However, of all the families there was only one who attended the construction site every day. It is therefore questionable to what extent the families are actually capable of reproducing the knowledge. Despite this fact the families that worked with the teams operating with support had at least one family member attending the site every day. The control group family was not on site throughout the project and consequently never participated in the actual building process, even though their brothers and nephews did. Moreover, suggesting that they only needed the external knowledge (team) to make a design and to offer funding to realize the house.

Outcomes: In their current housing most, families already required external (paid) knowledge to realize their housing. Here, the chosen new solutions were (bricks, roofing sheets and door/windows) mixed with old solutions, requiring external knowledge to be applied. The level of required external knowledge would only increase if inhabitants would follow their material preferences articulated in their desired housing. As the control group almost entirely copied the desired housing materials it does not come as surprise that they mainly require external knowledge (now and in the future).

The low level of family participation led to a limited transfer of knowledge for all the teams. Fathers often were not present on site due to work and the children had to go to school. As a result, it was the mothers who often participated in between the daily chores. With different family and community members present on site the teams were not able to consistently train specific family members and the knowledge transfer were therefore limited. Nonetheless, the teams with support had substantially more family members participating throughout the project. This is one of the reasons why the teams with support were able to reach comparable skill and knowledge levels as seen in their current housing.

External Housing Model: Factor IX

Current Housing: All families needed external help from the team to improve their current living situation (see Figure 6.14). Moreover, they needed help from a multitude of solutions: building method, materials, knowledge, training, articulating a housing plan and design. These external capacities grouped into a housing solution is called and external housing model.

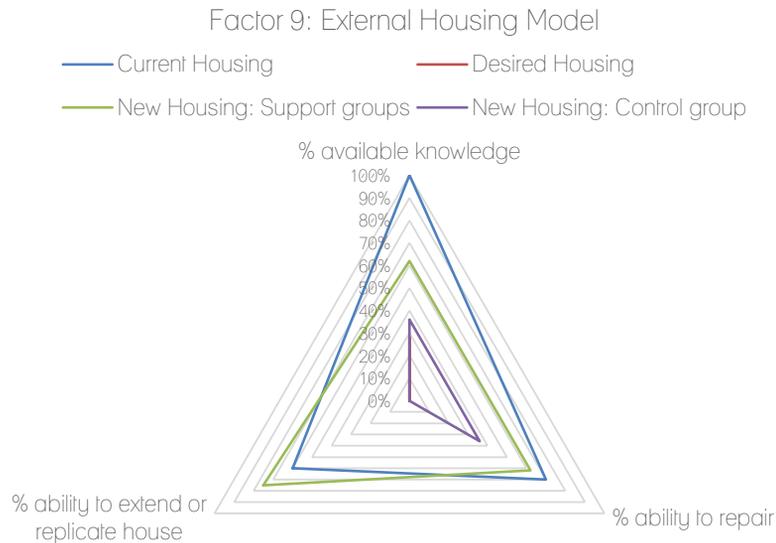


FIG. 6.14 Interview outcomes, external capacities, housing model

Desired Housing: All families prefer external materials that would involve external knowledge and skills which would require them to hire skilled labour (see Figure 6.14). The majority of the families think they need external solutions (model) and the team to articulate improved housing solutions.

New housing: Two families found the implemented external housing model (team + Support Tool) took too much time, the focus from the start should have been on constructing and less on researching (see Figure 6.14). As explained previously the decision to build this type of house and out of which materials, were made by the family and team in the support groups, which was not the case with family 11 and the control group.

Outcomes: The families already used external solutions (materials, skills and tools) to adapt their current housing and would only further increase if they would follow the desired (external) housing model. However, as discussed, the families do not have the capacities to apply the desired housing model and require external help to offer alternative solutions. Moreover, these solutions are captured in various external housing models articulated by the teams together with their families (excluding **family 5** & family 11).

6.1.4 Articulation Phase

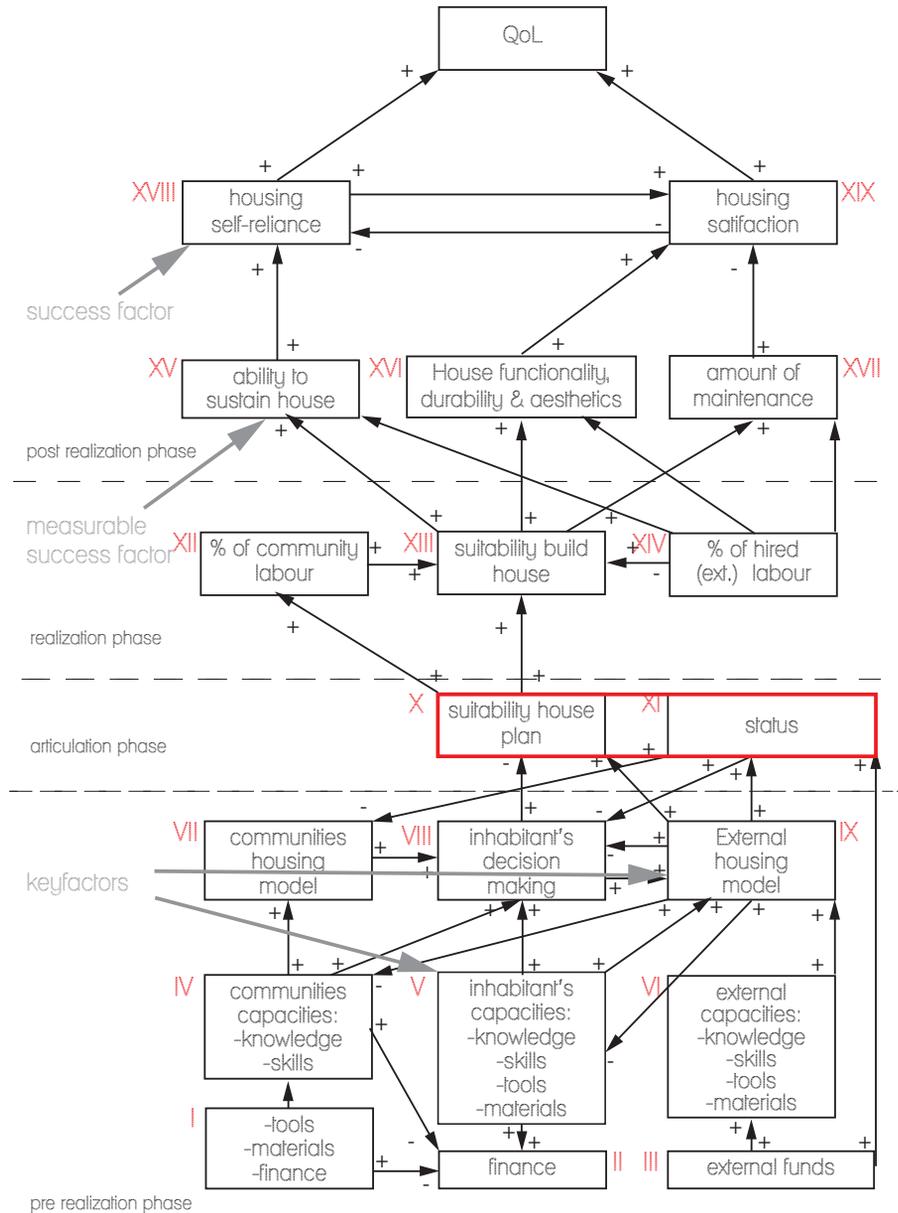


FIG. 6.15 Impact Model, inhabitant capacities

Suitability Housing Plan: Factor X

In current housing the preferences and decisions were not rendered in a housing plan⁶. In current housing, materials were gathered or bought according to available funds and donations. Commencing the construction of the house would simply start when the required materials, tools and labour (family, neighbours and community members) were available. Therefore, it was not possible to measure the impact of the articulated new housing plan with those of the current or desired housing plan (as there weren't any). There was one question that addressed if the families would have preferred to build their current house differently. All families confirmed that they indeed would have, and mainly with external materials. However, that they had insufficient funds to do so, indicating that the families would have preferred to articulate a more suitable housing plan, which they could not afford.

Outcomes: In the current housing the families did not make physical housing plans. Houses were built according to the family's available resources, making the plan for traditional housing flexible and suitable to the family's capacities. Although the families prefer a more formalised housing plan and building materials for their desired housing. This requires the families to accumulate high financial resources to realize the housing. As their livelihood is largely dependent on their financial means (food, schooling, etc.) it puts tremendous restraints on the size of house they can realize and results in a limited suitability of the housing plan. Moreover, this type of housing is less adjustable to the changing requirements of the family (size of the family). Although the interviews did not prove that the housing suitability declined, it can be observed in the overall research.

Housing Status: Factor XI

Housing status⁷ was the major unforeseen factor in the experiment. The type of housing a family has seems to define the social position they hold within the community. It influences who the families associate with, moreover, the chances they have in improving their livelihood. While conducting the baseline interviews some of the answers given by the families did not only point towards a functional improvement to the house but sometimes mentioned inconsistencies between what they desire and what they can actually afford (within their capacities). Although it is extremely difficult

⁶ Housing plan: a proposed scheme or design of a house.

⁷ Housing status: (perceived) social position one experiences in relation to their housing.

to prove that this is the case, after conducting the impact interviews (especially with the control group), this factor had to be included in the research.

Current & Desired Housing: All families found their current housing too small and didn't like materials used for walls and floors. They would consider cheaper alternative materials with similar characteristics to external materials for their desired housing. However, some of the families prefer to have the house build for them even though they can clearly not afford that. Indicating that housing status is closely related to the family's ability to have a house built rather than self-built.

New housing: When asked what they liked about the new house two families stated the design, to others that the house is self-contained or permanent and one that it's a new generation (typology). When asked what makes their house special, two families answered: it's permanent, one that since birth they never lived in such a house and for one it's due to the materials used. Between the families there was not much difference to report, however, the control group came with a significant insight. When asked if their relationship with community members changed due to their new housing, the father answered:

"[...] So, we have two categories [of people] here: so, we have those who we dislike and those who like us. So, for example this house has put me to the level, with those now, [...] who have the brick houses now they are a friend of me [...] We have those who we appreciate, because they now have reached the level and those we don't appreciate because they don't [...] So, when you move from one class, you cannot expect friendship for another class."

Although this is just a statement of one family, it had such a significant new insight that it seemed important to add housing status as an influential factor for inhabitant's decision-making process (Factor VIII) in articulating desired housing (Factor X).

Outcomes: Some of the families' housing preferences are inconsistent with their capacities. Although they are aware of their limited financial means, they prefer expensive (but durable) materials that require hired labour for application. There is insufficient proof, there is a preference of the families to use as many manufactured non-natural materials as possible. Although this can be explained by the efforts to realize a permanent house with a low level of maintenance, some statements about the new housing such as: a modern house, can't be ignored. The control group gives a valuable insight that for them having their desired house built, has enabled them to belong to a different social class. One which in their words only consists of families that have a comparable (permanent) house.

6.1.5 Realization Phase

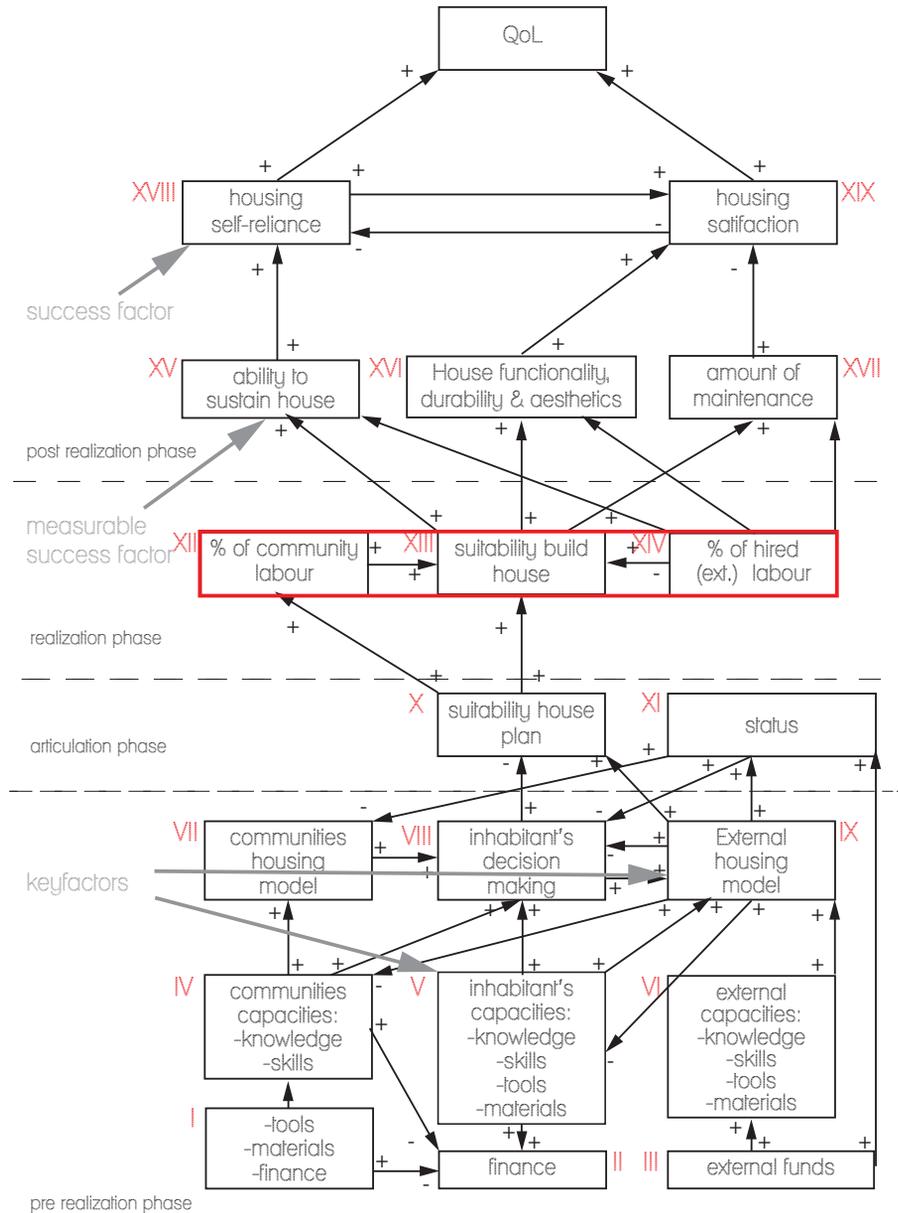


FIG. 6.16 Impact Model, inhabitant capacities

% community labour Factor XII, Suitability built house Factor XIII & % hired (external) labour: Factor XIV

Current Housing: If the families had to transport materials for their current housing, they all had to hire labour (see Figure 6.17). Only one family received help from their community in constructing their current house. However, when asked if they had help and from whom the majority answered they did have help from their community. All families built the most of their house by themselves, supported by their family. However, the majority of the families partially depended on a hired labour, mainly for part of the works and in one case most of the works. Only one family require a hired engineer to make repairs to their house. All families stated that the knowledge and skills necessary to build desired housing are so complicated that they need to hire an engineer.

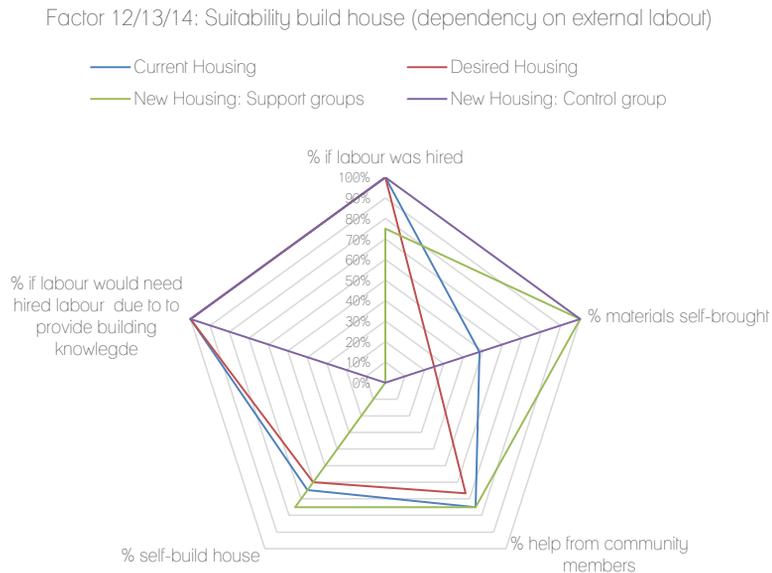


FIG. 6.17 Interview outcomes, realization phase, suitability of the built house

Desired Housing: The majority of the families prefers to build their desired house by themselves, however two families prefer to hire labour (see Figure 6.17). The majority of the families would need to hire transport for most of the materials, although one family thinks that most of them are locally available. Only two families

think that they would receive help from their community, the majority of the families does not think the community members they helped in the past will help them in return. As a result, most families would need to hire labour for some or even in one case for most of the works to construct their desired house.

New housing: All families have a new house, however they are not completed. In their opinion the main reason was due to a lack of time, the majority thinks they will need a year to complete, two families need a couple of weeks (see Figure 6.17). Parts of the house that require completion are the roof, doors, windows and floor. Only two families think that they will receive help from the community to finish the house. Looking at the complexity of the works and lack of help from the community, all families answered that they will need to hire labour to finish the house. All families had a brick house realized (although very different types of bricks), where three found this to be a permanent house. Only one family was present at the construction site every day, where the majority was not. Almost every family (fathers) thought they were involved enough, due to the presence of other family's members each day. The levels of involvement differ strongly between the families, here family 8, 11 & 5 had a low participation and family 1&4 had a high level of participation. All families received help from their family, friends and community members, although one family did not really received help. Although the control group answered they did receive help from the community in the control question they answered that only their family helped. All support group families considered the help to be substantial. The majority (one did not) of the families hired labour to construct their new house, in two cases for all of the works and in the others for some of the works.

Outcomes: The families mainly built their current housing by themselves (high factor 13), supported by their friends, family and community members (high factor 12), and where needed, supervised by hired labour (low factor 14). The teams that used the support to articulate a new house were largely able to sustain this level of self-build practice within the families (high factor 13), however marginally supported by their community members (low factor 12) and often with additional hired labour (average factor 14). The control group shows that they articulate a new house which they were unable to sustain the current level of self-built practice within the family (low factor 13), not at all supported by their community members (zero factor 12) and completely built with hired labour (high factor 14). The control group therefore largely aligns with the desired housing (hired labour), where the other groups were able to sustain self-built housing.

6.1.6 Post-Realization Phase

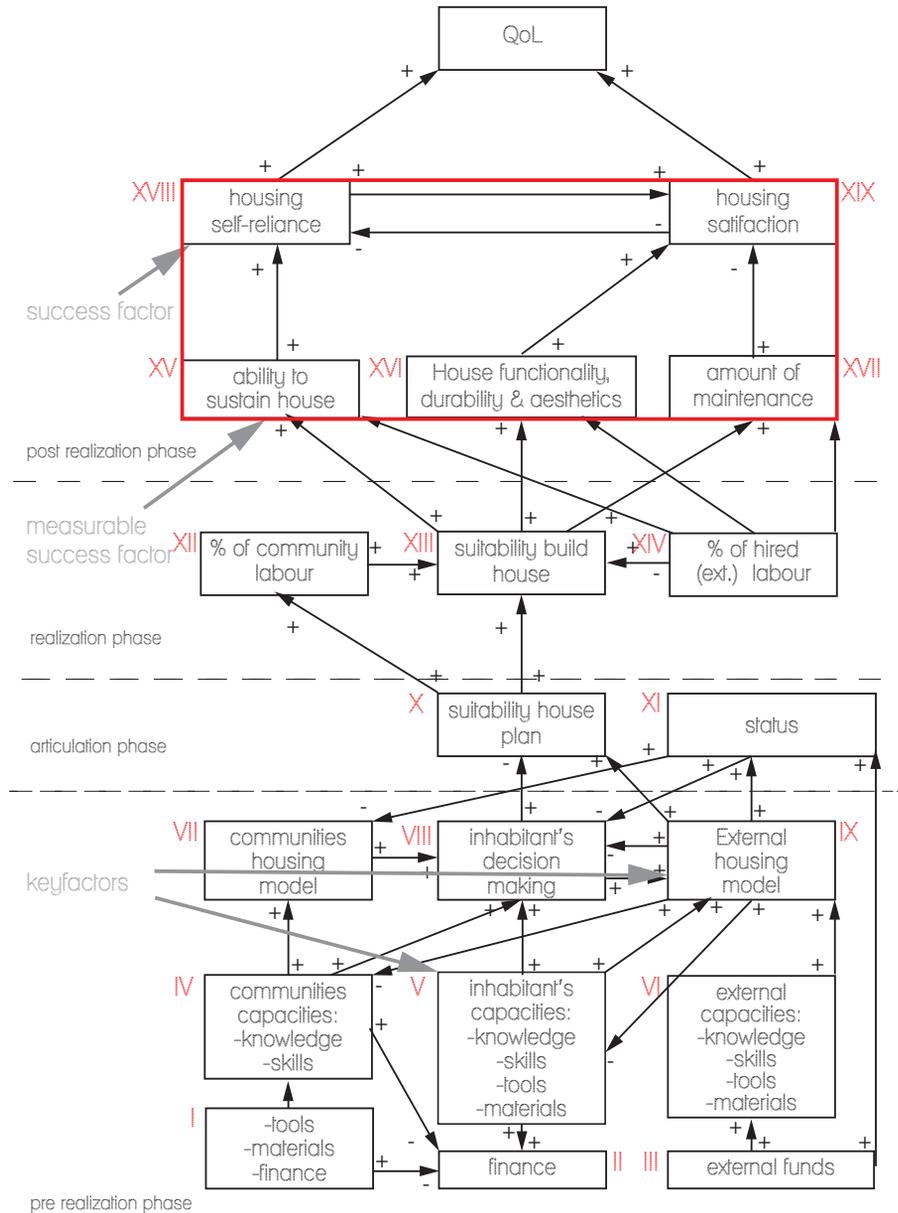


FIG. 6.18 Impact Model, inhabitant capacities

Ability to sustain house factor XV

Current Housing: All the families are able to repair the walls of their current house by themselves, two families state that they can repair most of the house (see Figure 6.18). The majority struggles to repair the roofs and in individual cases doors, windows or cement floor. One family thinks they can do all repairs.

Desired Housing: None of the families would be able to extend or replicate their desired house (see Figure 6.19). However, if they would be taught how to build their desired house they would repair their own house.

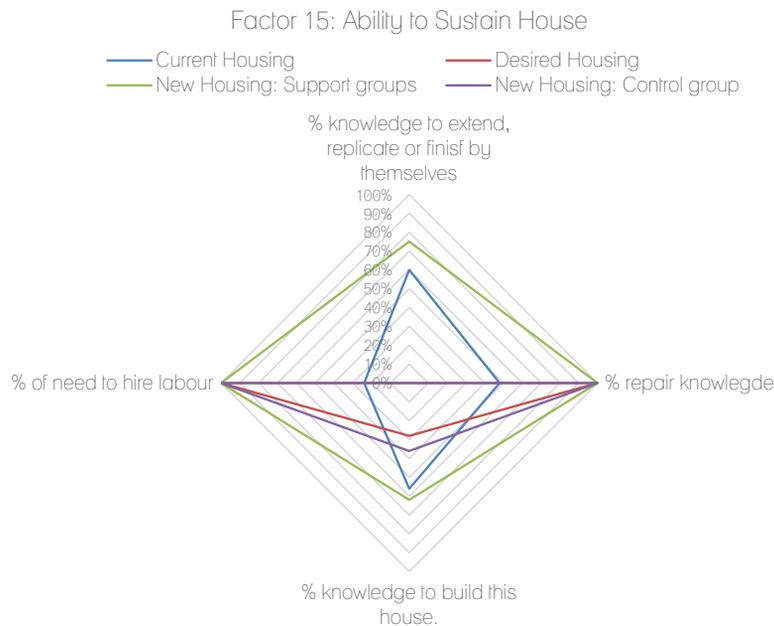


FIG. 6.19 Interview outcomes, post-realization phase, ability to sustain house

New housing: All support group families will finish their new house and have the means to do so, the control group won't be able to finish and does not have the means to finish in the foreseeable future (see Figure 6.19). The support group families have the knowledge and skills to finish the house by themselves, the support group does not. However, the support group families needed the team to offer the knowledge and train them, moreover, all families need to hire labour. The majority (except the control group) thinks that they will be able to repair the house and can

afford the repairs if their income decreases. Moreover, they know how to extend and replicate the house by themselves.

Outcomes: Although self-building practice is strong in current housing, there is limited ability to repair the houses by its inhabitants, this is mainly due to the application of external materials. Families indicate that they would not be able to maintain (inability to extend or replicate) their desired house. And even though the desired materials/solutions require intensive training, they still have a strong preference to maintain the house by themselves. In their new housing there is a significant difference in the ability to finish and maintain the houses between the control group and groups that did receive the support.

The control group was only marginally able to share knowledge during the construction process, which is contradicted by the family, that thinks is able to repair the house. This seems highly unlikely due to a lack of participation and training during the overall duration of the project (also expressed in their stated inability to extend or replicate the house by themselves). Moreover, the family lacks the means to finish the house and can't they afford repairs if their income diminishes.

The groups with support were able to share knowledge and train their family or community members during the construction of the house. It enabled the families to maintain their house and their affordance if their income diminishes.

Housing functionality durability and aesthetics, factor XVI

Current & Desired Housing: The current houses size vary between 30-105 square meters. The majority of the families think that the house is too small, while the main cause is their inability to let children (boys/girls) sleep separately, which in this community is considered the norm. None of the families are satisfied with their current house, mainly due to the size and in some case also: materials, comfort and presence of rodents (see Figure 6.20). The majority of the families had to repair their walls and roof quite often. When asked what (about the house) they would have done differently, all families listed external materials and two families answered that they would have preferred to have a modern house. As stated, before this would require substantially less maintenance than their current housing.

Factor 16 & 19: House functionality, durability, aesthetics & Amount of Maintenance

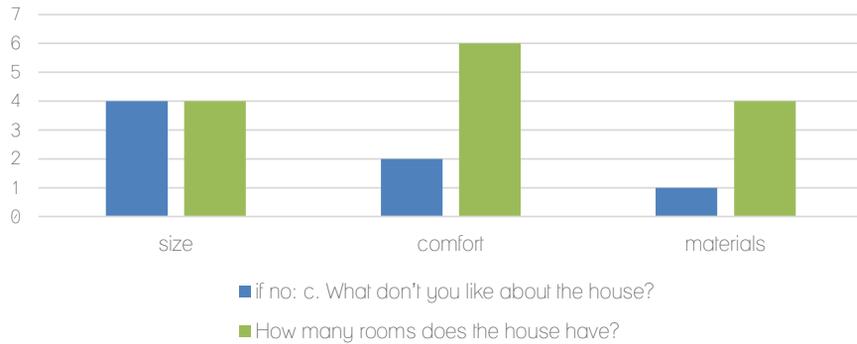


FIG. 6.20 Interview outcomes, post-realization phase, house functionality/durability/aesthetics & amount of maintenance

New housing: In the new housing most of the families either got larger houses or comparable to their current housing, the majority has an increased number of rooms (see Figure 6.21). They all find the new house large enough for the entire family. When asked what they like about the new house the answers varied: permanent house (2), design (2), new generation, size, self-contained, security and ventilation (1).

Factor 16 & 19: House functionality, durability, aesthetics & Amount of Maintenance

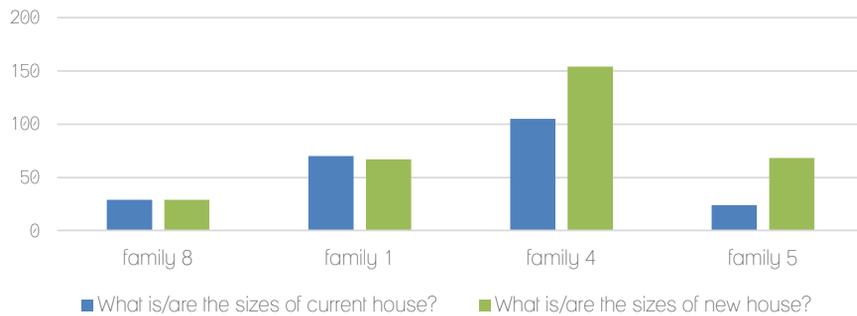


FIG. 6.21 Interview outcomes, post-realization phase, house functionality/durability/aesthetics & amount of maintenance

Outcomes: All families stated that they are dissatisfied with their current housing, mainly due to size, materials, comfort and rodents. Here, the floors and walls require most repairs. Their desired housing is larger and made of other materials (mainly external), which for some of the families would articulate improved housing that would require less maintenance. Looking at the functionality, durability and aesthetics of the new houses, there is no significant difference between the control- and support groups. They all realized a comparable or larger house, they have more rooms resulting in housing that fits the needs of the families. What they like most about their new house: permanence, design, new generation (typology and materials), size, being self-contained, security and ventilation.

Amount of maintenance, factor XVII

As stated before, within the available timeframe of this research only the short-term maintenance can be assessed. The frequency of current housing repairs differs strongly between the families: weekly, twice a year, once a year and once every 5 years. All families find that the walls require the most maintenance, where in one case, the floor or roof (see Figure 6.22). The estimated frequency of repairs in their desired housing is quite different. Here, all families think that their desired house would not require a lot of maintenance, stated frequencies are: once every two years, one once every five years and two families think that the house will be permanent, therefore won't require repairs at all. In the Impact interview none of the questions inquired directly on maintenance frequency. However, when asked what the families liked about their house, some of them did referred to the permanency of the house (see Figure 6.23).

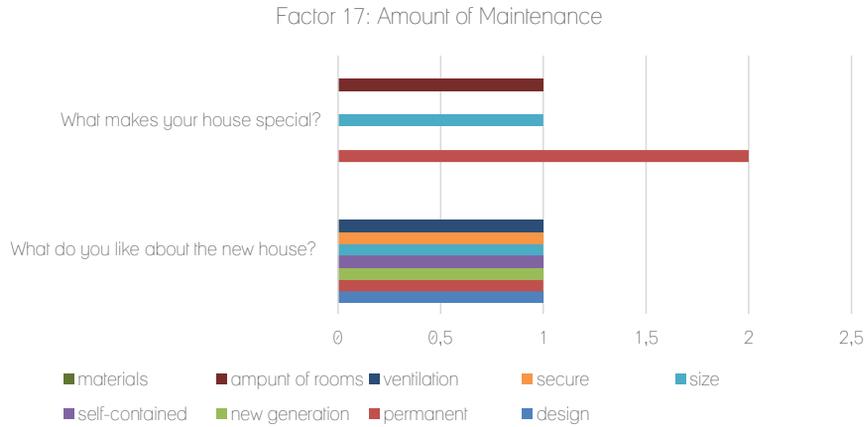


FIG. 6.22 Interview outcomes, amount of maintenance

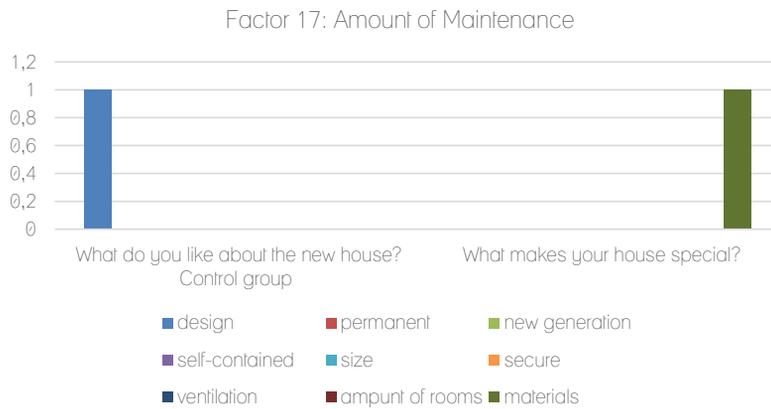


FIG. 6.23 Interview outcomes, amount of maintenance

Outcomes: Although maintenance frequency in their current housing differs strongly between the families, they all found that the walls and floors demand the most repairs; that they all expect the frequency of repairs in their desired housing would be substantially lower or not required at all. The impact interview did not contain questions on how much maintenance the families think the new housing requires, however the choice of materials indicates that most houses would require less maintenance. Moreover, some of the families stated that they like the permanency the most on the new housing.

Housing Satisfaction, factor XIX

Current housing: The average house (3 families) has 2 rooms (BI.PP.CH.F19.Q4) and is between 30–50 square meters (BI.PP.CH.F19.Q3), the families with more means (30.000–50.000 Ksh) have between 5–9 rooms (BI.PP.CH.F19.Q4) and 70–110 square meters (BI.PP.CH.F19.Q3). All families stated that they're not satisfied with their house (BI.PP.CH.F19.Q18), main reason is the housing size (BI.PP.CH.F19.Q5), mostly for their children or ability to host guests (BI.PP.CH.F19.Q5b).

New housing: The majority of the families' new housing is larger, with more rooms, which they all perceive as sufficient for their families. All families (except family 8) are satisfied with their new house, when asked what they like or what makes their house special, the majority of the families stated: permanency and materials as important factors.

Outcomes: The most important parameter for the housing satisfaction was size and correlated the amount of rooms the house offers. When comparing the outcomes of the current to the new housing, all houses have either remained the same in size or have increased. The same counts for the amount of rooms, which have increased for all families. As an effect all families (except family 8) are satisfied with their house. Additional reasons for housing satisfaction are: permanency of the house and applied materials.

Housing Self-reliance, factor XVIII

Current housing: Three families owned, and two families rented their current house, however, all of them own a plot to build a new house on (see Figure 6.24). All families repair their current house by themselves, which in most cases mainly involves the walls and floors of the house. The majority of the families think that they can afford the repairs if their income diminishes, however, this only counts for the non-manufactured natural materials (for walls and floors). For the other materials (parts of the house) the majority would need to hire labour which they cannot afford if their income diminishes.

Desired housing: The majority of the families think they need the help of the team in order to realize their desired housing (see Figure 6.23). In case the families answered that they would repair desired housing by themselves, two think they can afford and two think they cannot afford repairs if their income diminishes. All families would like to learn how to construct/repair their desired house.

Factor 18: Housing Self-Reliance

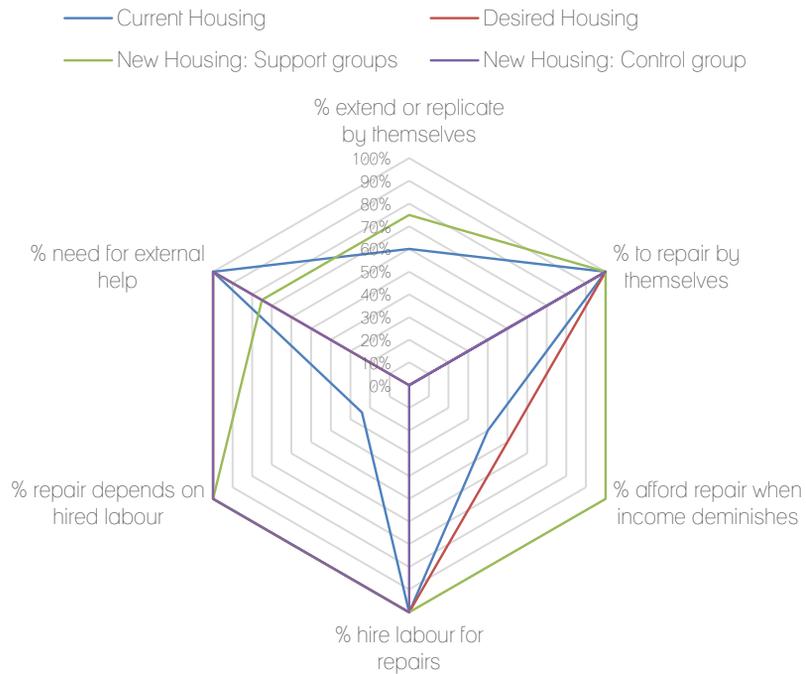


FIG. 6.24 Interview outcomes, housing self-reliance

New housing: Most of the families stated that they have a new house; only one family stated that they have an incomplete house. Which is odd considering the fact that only the control group was able to finish the carcass shell of their house (no finishes). All families require hiring labour to finish their house and all of them decided to keep their old house. There are also significant differences, mainly between the control group and the support groups.

The control group cannot afford to repair the house if their income declined and is unable to extend or replicate the house by themselves. Although the family thinks that only the shape and bricks resemble those of the community, it is clear that almost all materials resemble those of improved/desired housing examples in the community. A comparable discrepancy that can be observed in their ability to repair their house, which they state in the interview to be high, however, considering their lack of means, involvement and available knowledge (repair/maintenance), seems unlikely.

The support groups found them to be able to repair their house by themselves. They can afford it if their income diminishes and that they are largely able to extend or replicate the house by themselves. These families find only few similarities with other housing in the community, indicating that indeed new solutions are articulated there. However, there are similarities with desired housing examples in the community (use of bricks, cement, iron sheets, etc.).

The majority of the families needed the help of the teams to articulate improved housing (except family 11). However, there is a substantial difference in why they required it. The control group family stated that they needed the team to design and finance the project, where the other families needed the help in offering new: brick technologies, type of foundation, measuring, motivation and initiative.

Outcomes: All families own a plot where they can build a house on. They repair most of their current house, which they can still afford if their income diminishes. However, this does not count for the non-local materials. For these the families require hired labour and won't they be able to afford them if their income diminishes.

The majority of the families need external help to realize desired/improved housing. Two families think they would not be able to afford the repairs of this desired house if their income diminishes, two other families think they would. All families would like to learn how to construct/repair their desired house.

All families have a new house, although none of them are finished and require hired labour to complete, resulting in the majority of families keeping their former housing. The control group does not know how to extend, replicate or repair their house, furthermore, is incapable of funding repairs if their income diminishes. Their new house almost completely copied the desired housing model available in the community. The support group families are able to extend, replicate and repair their houses. Moreover, they can afford those repairs when their income would diminish. Most families only found few similarities of their new house to know housing solutions in the community.

All families needed external help to articulate improved housing, however, their motives differ strongly. The control group needed the external support to provide with funding and a design, where the support groups needed support to offer new brick technologies & types of foundations, for measuring, motivation or initiative.



6.2 **Goal B: Describes users' recommended adjustments to the tool and its effectiveness**

This section presents the adjustments recommended by its users in two subsections. The first section describes the direct feedback of the users (support groups) written inside the Support Tool. In the second subsection a survey of the users gives the reflection on the overall usefulness of the tool and lists the suggested improvements.



6.2.1 Outcomes Goal B1: Gathering written feedback from the participants on the support

In accordance with the set evaluation framework the support tools users had the opportunity to make comments and write feedback physically while being in the field. The image below (left) is an example of comments made by one of the users. These comments are mostly very detailed and about the text itself or indicating small changes. Therefore, all these comments are gathered to make one document listing all the 'textual' changes in review to the original. These changes will need to be weighed and addressed in an improved version of the Support Tool. The results of the overall PhD research therefore will solely present the recommended adjustments to the support, that need to be made, however, won't present the improved Support Tool (see also chapter two).

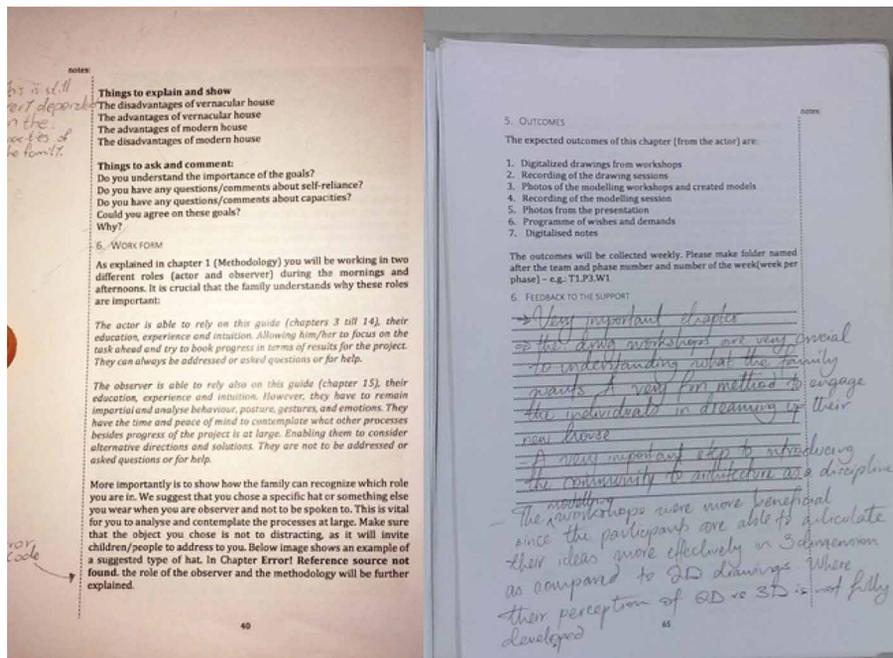


FIG. 6.25 Example sheet of in-text comments (left), example of chapter feedback (right)

As the chapter comments (see right image: Figure 6.25) largely react on the usability of the chapter in the field, this section will elaborate on the chapter comments made by all participants chronologically. The teams consisted of both an architect and a student, which present a substantial difference in the application of the support.

For clarity the feedback is presented separately. However, the support was meant for both students as for professionals and is therefore equally important to make improvements to the support. The complete overview of the chapter feedback can be found in: Appendix Q.

Procedure feedback analysis

Some of the feedback can be more lengthily than needed, has spelling mistakes or aim at experiment procedures (not part of support feedback but experiment). Therefore, the following changes have been:

- 1 Spelling and language mistakes were corrected, and sentence structure improved, without changing its intent.
- 2 Adjustments: some of the comments were written in a hurry and sometimes unclear or difficult to understand at all. Based on the end-interviews (also used in the next section) the answers were made slightly more comprehensible.
- 3 Separation support from experiment: the feedback on the design, execution of any other procedural aspects of the experiment (not the support) has been separated and will be presented in the recommendations.

In Appendix R, the entire analysis of all feedback is presented. The coding explains how the feedback was treated. Per chapter the most important feedback was gathered, which can be found in: Appendix S. Below an overview of the most important feedback per chapter is given.

Introduction section, Chapter III: Introduction

The chapter described a weekly feedback session between the team members, in the support this moment was planned on the Sunday's. In Kenya people are accustomed working 6 days per week, consequently the teams spend 6 days per week in the field. However, the teams explained that they needed at least one leisure day per week and therefore the session needs to be moved to one of the working days. The support explains that the observer needs to wear something notable that makes their role for that day clear. However, most of the teams found that when you explain the role at the start to the entire family and per day just tell them who the observer is, this works fine as well.

Introduction section, Chapter IV Key-topics & Chapter V Pilot project

Some of the statements are too bold or do not fit the actual situation of the community. It needs to be clearer which parts of the support are mandatory and which are for additional information. An introduction lecture (online) on how the support works will really help the reader to better understand. A flowchart or scheme in the introduction can have a similar effect while being in the field (see Appendix S, p.2).

Actor section, chapter I: Introduction to the family

The chapter now only includes the introduction of the team to the family and must include the introduction of the family to the team as well. The first meeting with the family needs to be removed and the team needs to immediately start with their introduction. The observer role in this stage makes the family uncomfortable and has sometimes limited effect for the team. Therefore, adjust or remove the changing of the roles to make the introduction more sociable and less scientific. Additional methods or games need be added which further relaxes the family in this stage. The fixed macro observation needs to be adjustable in the research phase of the project, in this way it allows more insights. During construction it has to be fixed on one point (as described in the support). The support now emphasizes on application by foreigners, excluding local architect Jackson, therefore needs to be changed to fit engineers and designers from outside the communities they target. The explanation on appropriate clothing has to be extended.

Actor section, chapter II: Daily routine interview

The team needs to be allowed more freedom to articulate the interview by themselves. Here, the support needs to provide with an interview guide, however, allow additional questions. After properly explaining the interview methodology this does not have to be repeated through the support (just use cross-referencing). This chapter has to be combined with the dream house chapter, so that while the family draws or builds, questions can be asked more informally. Extra explanation is needed on how to interpret different answers between family members. More importantly how these differences can be used to discuss the various opinions and find consensus.

Actor section, chapter III: Hopes and dreams workshop

The chapter needs to offer various methods, approaches, materials and tools. In this way the teams can adjust according to the abilities of the families: some family members struggle to draw, have limited three-dimensional understanding, etc. The workshop needs to be changed and divided between the parents and their children (privacy). Moreover, there is a advice that the suggestions of the children can be weighed appropriately to those of their parents (although this might be problematic in a patriarchal society). A step/method needs to be added which articulates a zoning plan, this can then be used (and helps the family) as a departure point for the rest of the workshop. The chapter has to elaborate more what a program of demands is and how it can be used (based on examples).

The dream house title is too suggestive and caused major misunderstanding with some of the families. Without clarification the families think that their dream houses will be built. All words in the chapter need to be adapted according to the change of title. Make the last step of the chapter optional (Actor section, Chapter 3) and add a closing session in which the team and family discuss the differences between what they desire and what is actually possible based on their capacities. Practical examples about foundation, walls and roof, explaining that these are expensive, moreover, require skills that the team simply can't transfer in the limited amount of time they have.

Actor section, chapter IV: Mapping, measuring and drawing

Elaborate how low shrubs are important in marking the plot, why the house has a certain orientation and how this relates to the position of types of spaces (private, public and semi) and functions (comment made by student who did not have mapping in their education). Also, why a specific radius of investigation is needed in this type of context. The introduction of the chapter has to make clear why this analysis is essential in making an inventory on existing capacities and how these can be used. The 3D terrain option in the chapter needs to be made optional. This chapter needs be combined with chapter VI which is a comparable analysis, but on a larger scale.

Actor section, chapter V: Observing daily routine

The support has to explain why an overlap between the interviews is required to interpret outcomes. The chapter leaves room for the user to define the role of the ideal observer, it would help the user if this chapter would conclude by describing the

ideal observer role for this context. A stronger emphasis needs to be made on how a personal relationship and involvement can increase understanding, however that the observer has to remain participant and not leader of the activity. Furthermore, the introduction needs to emphasize how the observation helps to find additional capacities (although this is stated clearly in the support). The observer section for this chapter can be used to observe a second family member at the same time. Moreover, the observation be shortened to one day as it provides with sufficient understanding, if the person has a regular daily pattern. Questions can then be added to better understand the differences with the weekend (leisure) days.

Actor section, chapter VI: Context depth analysis

The chapter needs to emphasize more why analysing capacities is important before articulating a design (although is elaborated extensively in the introduction of the support). The soil test was merely meant as an example, however the teams would request various and more elaborated examples (although this jeopardises the solution direction). Moreover, the described soil test example was incomplete (use of salt, straight bottles, etc.). The teams would also like more information how the differences in soils can be analysed and how they relate to various earth solutions (although this was not meant to be in the scope of the Support Tool). This chapter is essential for soil-based solutions, participation of the family and community might severely increase their understanding in their own capacities. The chapter has to emphasize more that you need approval to dig on other people their land (although you might expect that one would know that).

Actor section, chapter VII: Interview capacity analysis

Questions need to be added that address if and for how much materials and tools are available. A simpler checklist has to be made to examine possible skills. Like chapter II the users need to articulate their own interview based on examples given by the support. The family's situation can change over time, therefore a feedback loop with chapter IX must be added to confirm if materials and tools are available during the construction of the house.

Actor section, chapter VIII: Capacity impact analysis

A section has to be added how the budget can be monitored and adjusted during the project.

Actor section, chapter IX: User/community participation planning

This chapter needs to be adjusted to discuss the challenges between what the family desires and what they can actually afford. The work form has to support this process in such a way that consensus is reached between desired housing and what actually can be build. This in order to prevent the family from making decisions during the construction of the house that were not agreed by them and their team. The chapter must explain that the families have to start collecting tools and materials as soon as a consensus is reached on the housing solution. Due to cultural differences most of the building processes require more time than normal, therefore they need to calculate 10-20% additional time.

Actor section, chapter X: Start activities

The methodology has to be simplified; the chapter now requires a lot of time. The methodology needs to be less strict and a lot faster to fill in. Registering the training processes now takes a lot of time. The training needs to start way sooner and therefore this chapter needs to be spread over the other chapters.

Feedback to the entire support

The current version of the Support Tool depicted the community on Mt. Elgon in a far more traditional setting than the reality shown. It needs be applicable in other contexts that have various levels of development (income levels and capacities). This means that the average typology is very different. Moreover, the willingness to help or share capacities (materials and tools) is very low, which can be expected in a capitalist society. Everyone needs an income to sustain life and can't participate without being paid. The support must be adjusted to this low level of participation or offer methods that might work in various community development levels. It also has to be adjusted to suit families that have substantial financial capacities. Due to the experiment's setup the support was perceived very rigid and let very little room for selective application or own interpretation (although for the objectivity of the quasi-experiment there was no other way). As the name states it is a support not a experiment program to develop housing. Therefore, the framework of the support needs to allow loose chapters to be used.

All chapters must start with the expected outcomes, products and documents. All chapters have to be checked for redundant information. More emphasis has to be put on family involvement: how it offers small trainings that later on will be useful

for the building process. The observer section has to be incorporated in all chapters. More emphasis needs to be put throughout the support on the difference between desired and affordable housing. The experiment targeted individual families and has disturbed inner communal relations. It has to be considered to either realize a community project or to target local engineers (fundis) as they play a vital role in the development process of the entire community. In current form the support needs to emphasize on the help or support by a local engineer. The articulated building solutions must be widely applicable, so all residents of the community can benefit.

Feedback to the experiment

Due to the time constraints the amount of feedback by the users was limited and therefore has drastic consequences for its objectivity. Further research is required to get a fundamental understanding of the Support Tool application. The contracts of the family must clearly state that there might be team members with a different age or gender. That although these differences the families agree to make decisions jointly and the team them at any time from the decision-making process. The language criterion needs to weigh much higher than the other criteria. Moreover, it must not apply to one member but to the entire family.

Adjusting the Support Tool and experiment

All chapter feedback adjustments previously proposed are the first part of the evaluation of Descriptive Study II. As mentioned in the methodology section all parts of the evaluation are gathered in this chapter and will be used in postdoctoral research to articulate improved support.



6.2.2 Findings Goal B2: Participant support survey

The previous section presented the feedback on the support by the participants (excluding the control group). This feedback was handed-in throughout the experiment and reflects more on practical day to day findings. This section reflects on the second part of support evaluation framework. Here, in an extensive survey the participants reflected on the overall practical suitability of the support (see Appendix T). Looking back at the various chapters of the support and how they helped, frustrated or problematized the participants' effectiveness in articulating self-reliant housing on Mt. Elgon.

Survey methodology is selected as it allows detailed insights in the observations made by the participants (Fowler, 2013). In the survey a questionnaire helps to structure an interview to get a more elaborate understanding of the given answers (Muskat et al., 2012). The questionnaire was divided into three time-categories: before, during and after the experiment. For the most objective evaluation these categories could have been divided over three different evaluation sessions. Due to the extensive evaluation framework of the entire experiment, the participants were already overburdened. Therefore, due to different finishing times of the houses, only two sessions were held 30-12-2017 & 06-01-2018 (on Mt. Elgon).

The participants were not allowed to discuss questions or answers in the sessions and were requested to complete the questionnaire at once. Below the relevant questions (that aim solely on the support itself) of the questionnaire are elaborated on. They are divided into two categories: before and during experiment. Both sections will reflect on the methods developed in the support.

6.2.3 Before the experiment

The first questions evolved around the background (education & experience), approach (normally used methods versus that of the support) and role (responsibilities professional & client). In the approach students stated that (Smits, 2018, p.7): they would normally have a very short research period (more on the computer and less in the field) involving local professionals, organise few design meetings with the clients, use general information (Jellema books, Bouwbesluit and NEN), study on alternative building methods, try to offer them on a larger scope (community project) and most importantly allow teams to work together (this was done to prevent research bias). The architects stated that (Smits, 2018, p.7) they would have a similar approach to the support (used methods), they would have spent

more time on understanding local materials and crafts, their research would have been less detailed, therefore they would have started to build earlier. Which follows the student's notion that the support has to focus on developing a community project: organizing community workshops, including an inventory on the motivation to participate in a potential project.

In describing their role, the students state that in general they would actively participate in most aspects of the project (design, calculation, technical drawing, etc.). However, that their responsibility as a student would be limited: they are interns and therefore must not work independently. The need for a professional to tutor them in their role is an important factor. The architects state that (Smits, 2018, p.8): their role is rather traditional: making a design brief, a design-, technical drawing and managing the building phase. They perceive their role to understand the problems of the inhabitants and mainly offer design- and technical solutions. The emphasis would lie on training the inhabitants during the building process in order to enable reproduction of the offered solution. This does confirm the initial observation where professionals mainly perceive a solution for housing is offered through the building process.

In describing the relation with clients, both students and architects are similar in their understanding (Smits, 2018, p.8). The relation would be professional or formal, the main responsibilities would be: understanding the wishes, translate them into a design, managing expectations and guide through the process of realizing a project. The other topics will be discussed in the next section.

6.2.4 **During the experiment**

The first questions followed the same structure as the previous section: the background (education & experience), approach (used methods) and role (responsibilities professional & client). In the role section students stated that (Smits, 2018, p.13): they did not have a clearly defined role, most of the activities were performed together (with architect), that the level of responsibility is a lot higher in comparison to a normal project and that involved architects sometimes found it difficult to let the students in charge (thus excluding some of responsibilities from the students). The architects stated that (Smits, 2018, p.13): the relationship was very close, so close that it caused problems and distracted from the project. That due to the challenging and largely unknown location, their professional role was very different due to the cultural and social differences and made the size of the

assignment a lot bigger than normally would be required. However, that they were leading consultant and mediated between the clients and students.

The following paragraphs will focus on the evaluation of the support itself. Starting with the extend (10-point scale) the participants (6) found the support useful (0= not at all, 10 very useful) in articulating a housing solution, see Figure 6.26. The left side of the figure represents the number of respondents and the bottom the level of useful.

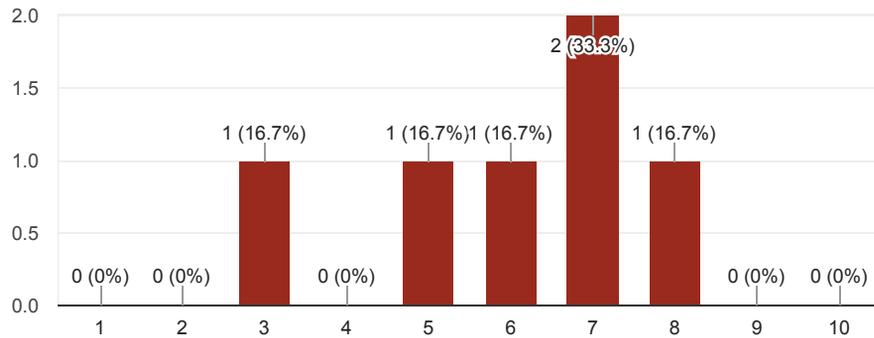


FIG. 6.26 Response survey question: To what extent did the support help you to formulate a new housing solution that would enable the family to maintain, extend or replicate it? (Smits, 2018, p.15)

Here 66% (majority) of the participants found the support to some extent helpful (score: 6-8) and 33% found the support limited in helping to articulate a housing solution (score 3-5)

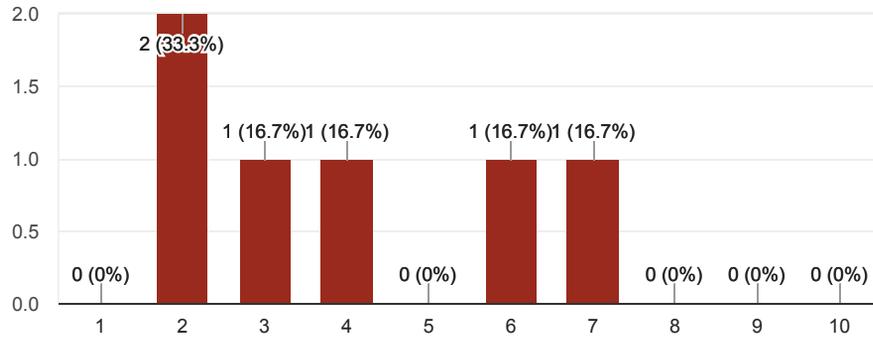


FIG. 6.27 Response survey question: To what extent you felt forced to use certain solutions (materials, building method, etc.) by the project organization in addition to the support, during the project? (Smits, 2018, p.18-19)

As the support did not aim at providing with the direct applicable housing solutions a control question was included. Here, the participants reflected on the extent they felt forced to use specific building solutions (construction, materials, etc.), both by the organization and the support (see Figure 6.27). In the survey, the majority (66%) felt only partially forced (score: 2-4) in specific solutions, 33% did feel forced to some extent (score: 6-7). However, in the subsequent interviews, all participants (100%) stated that they only felt forced in the building solutions at a very minor level (66% score 1-2 / 33% score 3-4). The comment that the researchers tutored the team into specific solutions was a misconception. Although the capacity-based solutions limited the options heavily, they did not force the team on a specific building solution.

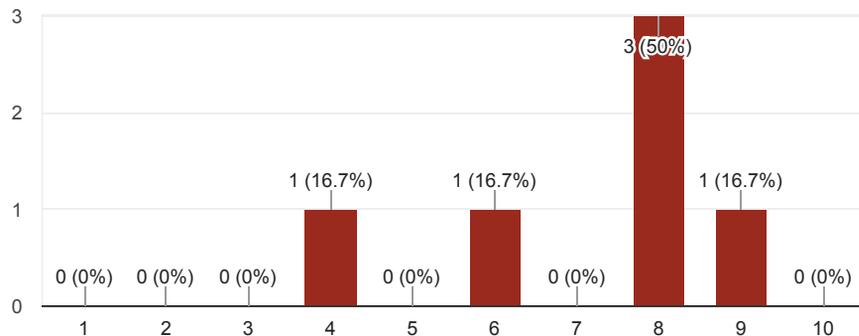


FIG. 6.28 Response survey question: To what extent were you able to research, identify problems and articulate solutions by yourself besides the support (as a team)? (Smits, 2018, p.19)

The majority of the participants (85%) found that the support allowed sufficient room for their own interpretation. Only one participant felt limited in articulating their own research, problem identification and solution articulation (see Figure 6.28). Participants found that there were no practical technical and design solutions given, therefore, they had to do most of the engineering and designing. Which shows that the expectations of the support needed to be managed better. A section at the beginning of the support needs to clearly state what the support is meant for and what it not to be expected from the support.

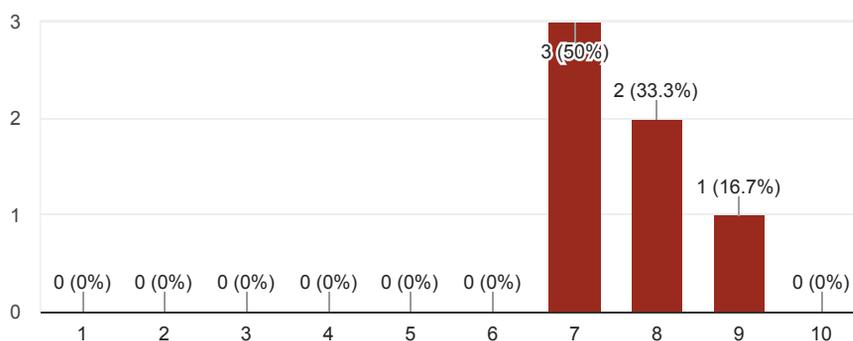


FIG. 6.29 Response survey question: To what degree have you executed the project according to the support? (Smits, 2018, p.19-20)

Understanding the extent in which the participants actually used the support is extremely important for the objectivity of the findings. To approach the extent a control-question was used to better understand the perspective of the participants. Here, all participants stated that they mainly executed the project according to the support (see Figure 6.29). When we look at the limitations these are due to the practical implications in the field. For example: community participation was low, the teams struggled to involve the families and as a result the knowledge exchange was limited. Therefore, executing chapter 10 (knowledge exchange) was limited. Another example shows that although the teams offered solutions according to their capacities, most families did not want to build within their set capacities. Making it very difficult to articulate housing solutions accordingly.

The following questions (Smits, 2018, p.18-20) looked at the applicability of individual chapters during the experiment. The original survey outcomes were altered according to the interview session held afterwards. When asking the participants which chapters helped with understanding the context, the majority (4 out of 6

participants) stated chapter 1 (introduction family) & 10 (knowledge transfer) to be most useful. Chapters: 2 (interview daily routine), 3 (dream house workshop) & 7 (capacity analysis) were listed by 3 out of 6 participants, making those selected most significant to understand the context.

For the design process the majority (5 out of 6 participants) stated chapter 3 (dream house workshop) and chapter 6 (context depth analysis) as most useful. Chapter 4 (mapping) & 8 (capacity impact analysis) were found useful by more than half of the participants. The participants found chapter 10 (knowledge transfer) as the most useful (4 out of 6) to increase self-reliance of the inhabitants.

The participants were asked if they felt if any chapters need to be left out. They found chapter 5 (observation) as least useful of the support (5 out of 6). In the control question later in the survey (Smits, 2018, p.23) this was also confirmed. When asked why they stated that in addition to previous chapters the observation did not present new data. Although useful the advice is to combine some of the chapters and make them less detailed (more condensed). Chapter 9 (planning) was pinpointed as problematic by half of the participants. This was mainly because the family and community were extremely difficult to organize. Although the identified steps for the overall project are useful, making a time schedule is considered useless.

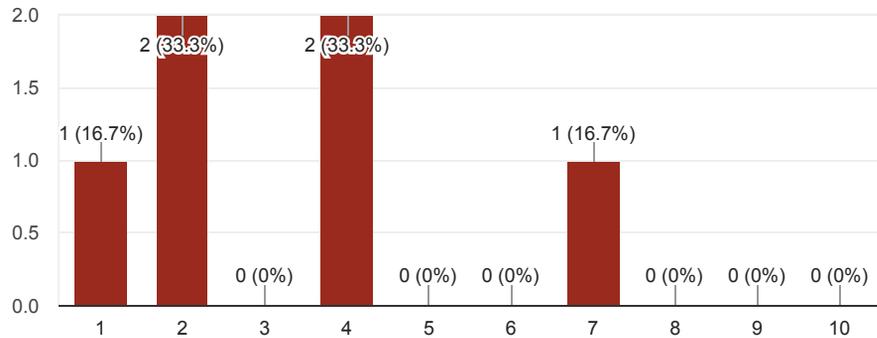


FIG. 6.30 Do you think the observer/actor role in working in this type of project/context is important? (Smits, 2018, p.22)

An important aspect of the support was the separation of the team in an observer and an actor role. During the various chapters the observer would register problems or improvements. During the activities or in the evenings the observer would give feedback, hopefully improving the effectiveness off the actor in future fieldwork. During the experiment most of the teams did not use this separation in roles. When

asked all participants voted for a low importance of the factor (see Figure 6.30). Main reasons were: no added value in separating role, a lack of time, observer sheets can be filled in with both being actor and is it unproductive to have an observer (only one team member is working). However, when the observer role is more on an interventional or optional basis, some of the users believe it will help.

The next chapter will address the outcome's reflection, conclusions and recommendations.



6.3 Findings Goal A&B in relation to research factors & key-components

The following section is divided in two subsections, separately describing the relation between the goal outcomes and the identified research factor and key-components.

6.3.1 Findings Goal A in relation to research factors & key-components

Section 5.6 described the framework necessary to evaluate the impact of the applied support in the context of Mt. Elgon.

The Prescriptive Study 1 described the required evaluation framework, consequently, the framework was tested in the quasi-experiment on Mt. Elgon (2017). Section 6.1 presented the main findings of the support impact on the participating families (Goal A) per factor (identified in the reference model). The interviews provided detailed insights and accounts of how the project has impacted families' housing situation. The outcomes were then correlated with the identified factors as shown in the initial impact model (see Figure 6.31). This subsection will start by describing of the main barriers and thresholds found in the impact of the experiment, followed by the impact the support and experiment had on the family's ability to sustain their new house in comparison to their former housing. In conclusion compare (support groups versus control group) the differences of the families' level of self-reliance regarding their housing will be given.

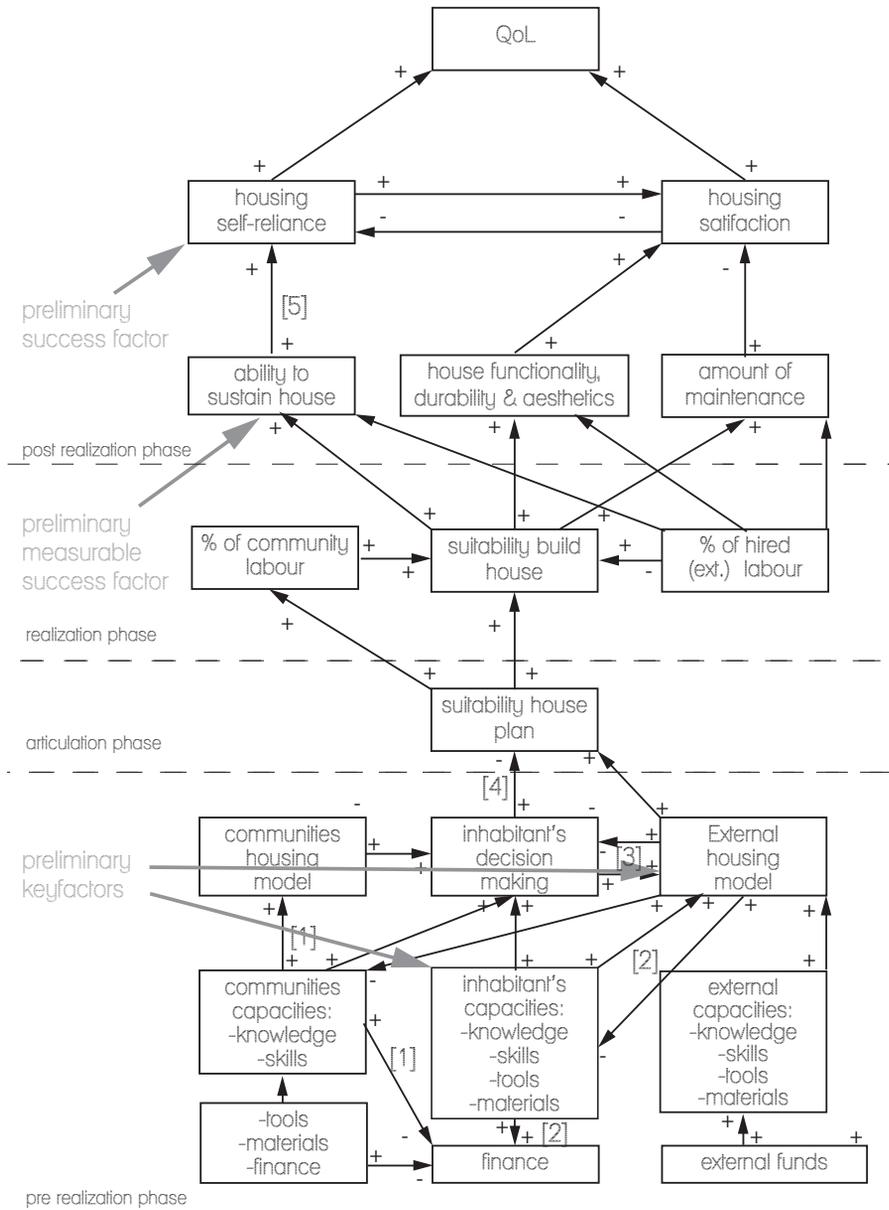


FIG. 6.31 Initial impact model (author, 2017)

Barriers

Outcomes (section: 6.1) of the experiment exposed three main barriers⁸ in constructing housing (see Figure 6.32). The first barrier lies in the extensive dependency that inhabitants had on external knowledge, tools and materials, in realizing housing. The support targeted communities which still have a high level of self-built housing. However, the level of self-built practice in the quasi-experiment's families was much lower than estimated. The families already lacked certain skills & knowledge in realizing their former housing and therefore, already were considerably depended on external capacities. This made the majority of the families accustomed to hiring labour instead of building the house by themselves. The second barrier is the families' preference to hire labour to realize their housing instead of building them by themselves, regardless that the majority of the families lack the financial resources to do so. Families that had their house built for them, seem to have elevated themselves to a higher social status in the community. Consequently, families aspire such housing as it creates more opportunities for them (work, schooling, etc.) The identified factor is now named status as it covers alternative motives for families to desire solutions which exceeds their current capacities.

The third and maybe most crucial barrier in the experiment is the role of local unschooled engineers (called fundis) which was omitted. The support only considered the family and their community in articulating solutions. However, fundis proved to be playing a vital role in housing development within the chosen community. A fundi advises families to prepare for future projects, help ordering materials and advise which labour to hire. Excluding this factor resulted in a major barrier in the project success. The teams participating in the experiment, had very limited local experience where the fundis' knowledge was almost entirely experience based. At start of the construction phase the teams were experimenting with their alternative building solutions and openly expressed their uncertainties. This increased the families doubts and uncertainties if the teams had the experience to build the house. This resulted with almost all teams in hiring fundis to help the team build the house. As the fundis didn't have any experience in these alternative building solutions they all advised the families to use known methods and materials (concrete, steel, etc.).

⁸ Barriers: are the factors which seem irreconcilable with the articulated support tool

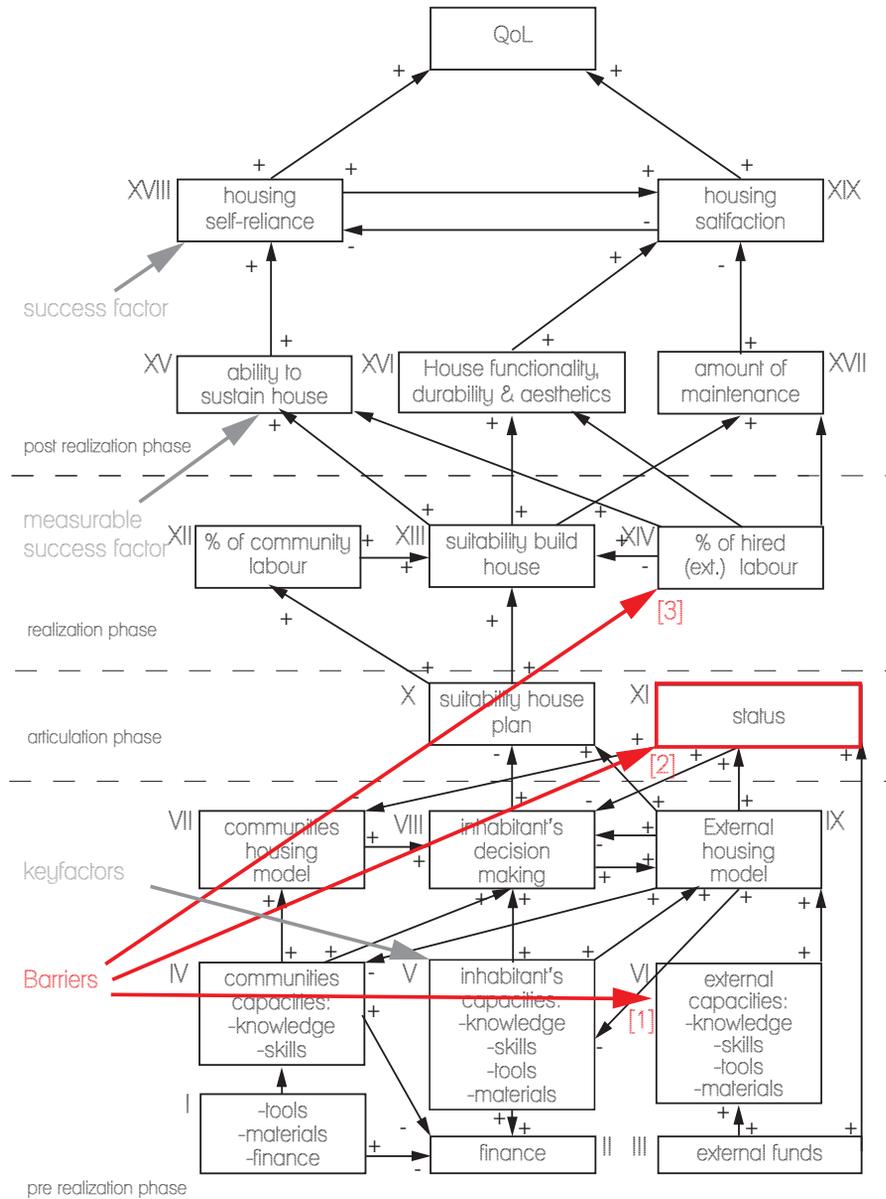


FIG. 6.32 Impact Model (author, 2019)

As a result, the families undermined the expertise of the teams and made executive decisions, mainly on material choices. Although the teams tried to explain the benefits of developed solutions (based on the family's capacities) to the families they often failed to convince them. Even though those were viable solutions for the families and might have had a tremendously positive effect for both families and the community. Fundis lack theoretical knowledge (calculation, planning, etc.) and have limited understanding on alternative building methods and inhabitant capacities. As fundis play such a fundamental role in the existing housing development, they need to at least be included if not positioned centrally in the articulated support.

Thresholds

Outcomes (section: 6.1) of the experiment exposed four thresholds⁹. The first threshold (see: Figure 6.33) captures the lack of sharing or exchange of capacities between families within the targeted community. In traditional housing the community shared knowledge, tools and materials, actively engaging in helping each other. Although it was previously observed that the community already moved beyond the sharing and exchange of capacities, it was the Support Tool's aspiration to conserve this aspect. The support therefore described how these capacities can be gathered and used in realising improved housing by the teams. Although sharing tools is still common, the sharing of tools or working without payment is not. The families have become largely capital depend and working without payment threatens their daily livelihood. Although the families are willing to help each other it is simply not viable for them.

As also mentioned in the first threshold the changes in the inhabitant's preferences have had major effect on the self-built housing practice. These preferences are captured in the community shared notion of desired housing, also called the community's housing model (see: Figure 6.33). In traditional housing minor differences in size or decoration indicated the position (status) a family held within the community. With the fading of traditional values, the communal regulation has slowly disappeared. Now the families can themselves decide which values they aspire and how these are reflected in their housing. Here, the size of the house and applied materials has become the measure of wealth and progress of a family. Families in the studied community therefore have a strong preference for non-local building solutions and largely reject traditional housing solutions. Consequently, the communities' housing

⁹ Thresholds: factors which formed obstacles for or followed from the articulated support tool

model leans towards an externally dependent housing solutions and no longer to community dependent solutions. Resulting in a low community participation in housing construction, identified as the third threshold (see: Figure 6.33).

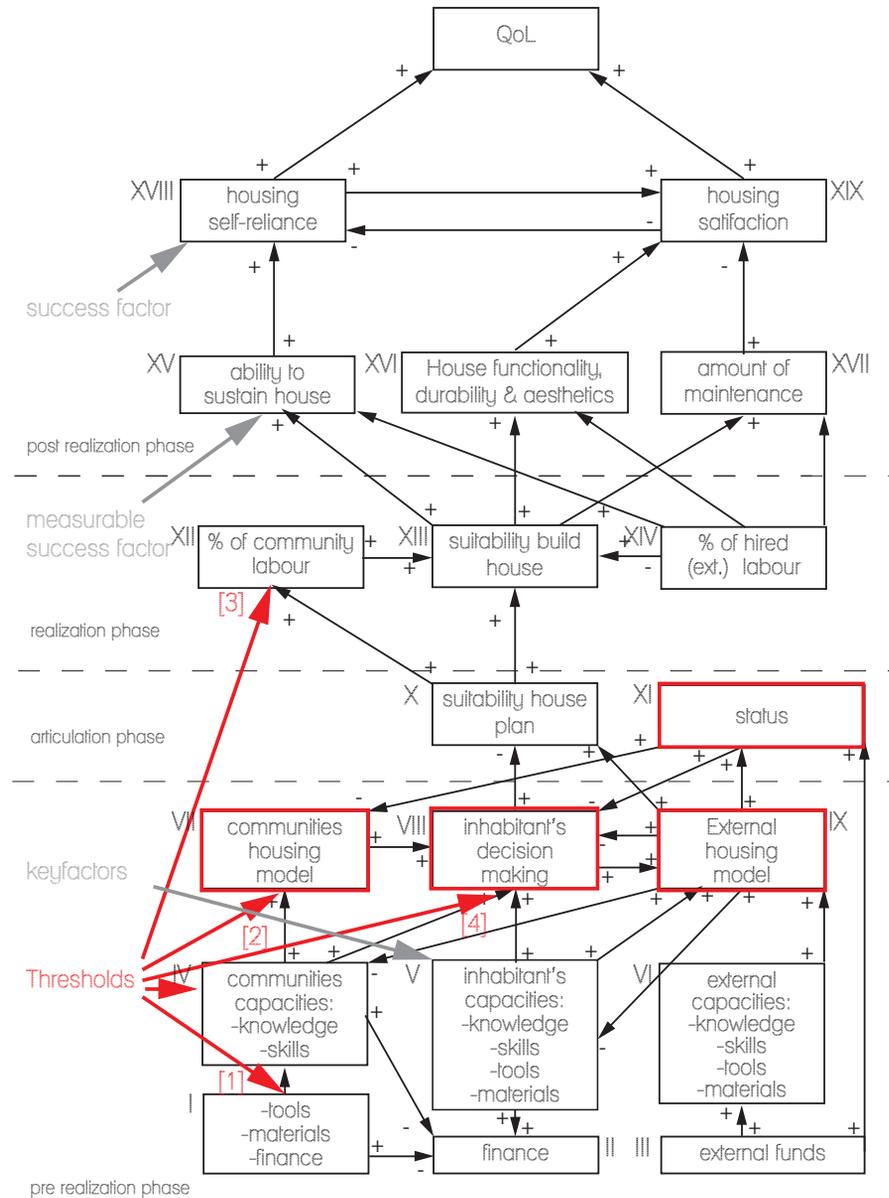


FIG. 6.33 Impact Model (author, 2019)

The fourth threshold was observed in the inhabitant's decision-making, which is very complicated to address objectively. The support intended to help the teams achieve a high level of family participation in the entire process. Although the team was leading the research and design phase, the family always made the final decisions. Although the teams succeeded in this aspect, it also confronted them with many problems. The support and teams aimed at convincing the families of housing solutions largely within their capacities, however, the families often decided to order non-local materials (in some cases deliberately excluding the teams from the decisions). As previously explained, this can be largely explained by the families' strong preference for non-local materials. Another important factor is that the families were not convinced by their teams. Solutions offered by the teams were experimental and never used before in this community and not 'yet' proven suitable for their context. Therefore, the families prefer to rely on proven and durable solutions that have already been applied in their community. The teams were very disappointed by the lack of transparency and ad-hoc decision-making processes by the families. However, keeping the family in charge of their decision-making process is still believed to be a key factor for sustaining housing suitability and satisfaction.

Impact: Ability to sustain house & level of housing self-reliance

Outcomes (section: 6.1) prove that the support group families have the means and capacities to finish their house and are able to maintain the house by themselves, even if their income got smaller (nr.1: Figure 6.34). The support groups applied significantly more local and sometimes free materials. The majority of the support group families found that the teams were able to transfer building knowledge to the family and have trained them on several parts of the construction process.

All families needed the teams to articulate improved housing as they were unable to do so by themselves (nr.2: Figure 6.34). The support groups made decisions jointly with their families, tutoring the family through the decision-making processes (nr.3: Figure 6.34). The support groups therefore not only realized a suitable housing solution (nr.4: Figure 6.34), even though they failed to finish the house within the timeframe of the support, but also enabled their families to sustain their house in the future. Thus, leading to an increased level of self-reliance of inhabitants regarding their housing.

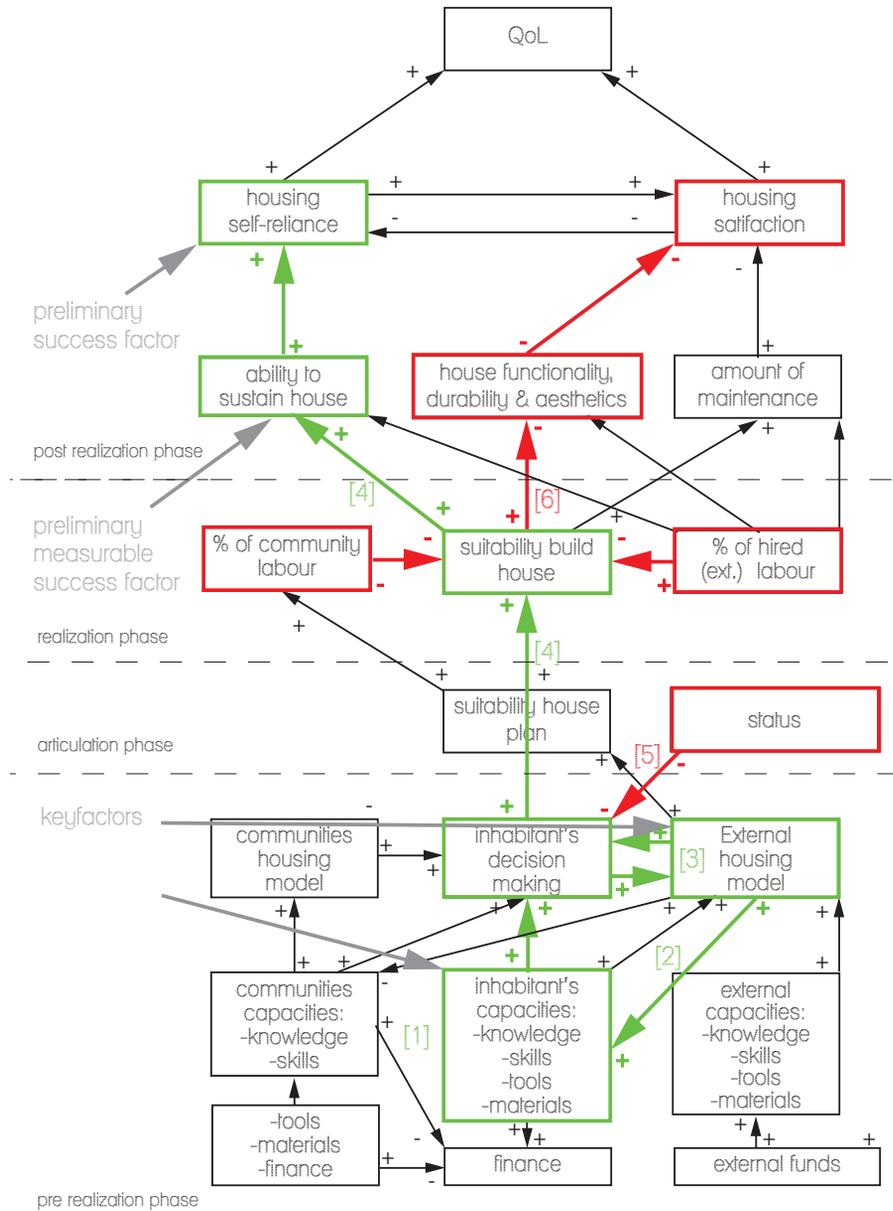


FIG. 6.34 Impact Model: support groups (author, 2019)

As expressed in the barriers and threshold the quasi-experiment also had negative outcomes. The level of community participation during the construction of the houses was low and the level of external labour dependency was higher than expected. Moreover, the degree of applied capacities was lower than initially assumed. The families found the solutions based on their capacities in some cases undesirable (nr.5: Figure 6.34), mainly due to the suggested materials which related to traditional housing solutions (not to a 'modern' house) and would require more maintenance. Both of those factors were perceived as negative outcomes and led to a lower housing satisfaction (nr.6: Figure 6.34). Concluding that the support groups increased (partially) the inhabitant's level of self-reliance, however causing lower satisfaction in comparison to the control group regarding their new housing. If the families are not convinced of the importance of self-reliance and the limited solutions, they will choose solutions that decrease their level of self-reliance.

The outcomes in section: 0 proved that the control group family does not have the means to finish their house and are unable to maintain the house by themselves (nr.1: Figure 6.35). The control group mainly bought non-local, manufactured materials that needed to be transported. All families needed the teams to articulate improved housing as they were unable to do so by themselves (nr.2: Figure 6.35). The control group family however stated that they only required the team to provide with a plan (design) and funds. Consequently, they felt that they made all the decisions and their team was only there to inform them (nr.3: Figure 6.35). A crucial factor (confirmed by the control group) was their decision to offer the family funds to realize the house and is in their words: their main regret (nr.4: Figure 6.35).

Due to the external funds the family was able to afford a house that would resemble their desired house (external materials, tools and labour), resulting in a housing solution that suits their preferred materials, aesthetics and functionality (nr.6: Figure 6.35). Moreover, it requires limited maintenance and therefore results in a higher housing satisfaction (nr.7: Figure 6.35). However, this has also led to a problematic housing suitability (nr.5: Figure 6.35). Here, the family is not able to finish the house by themselves (funds, materials, tools, knowledge and skills) but more importantly is unable to sustain their housing, leading to a deprived housing self-reliance. This is also reflected in the tension between housing satisfaction and self-reliance, where the family knows that they can only have an improved house if they can approve it, however, desire a house they cannot afford (nr.8: Figure 6.35).

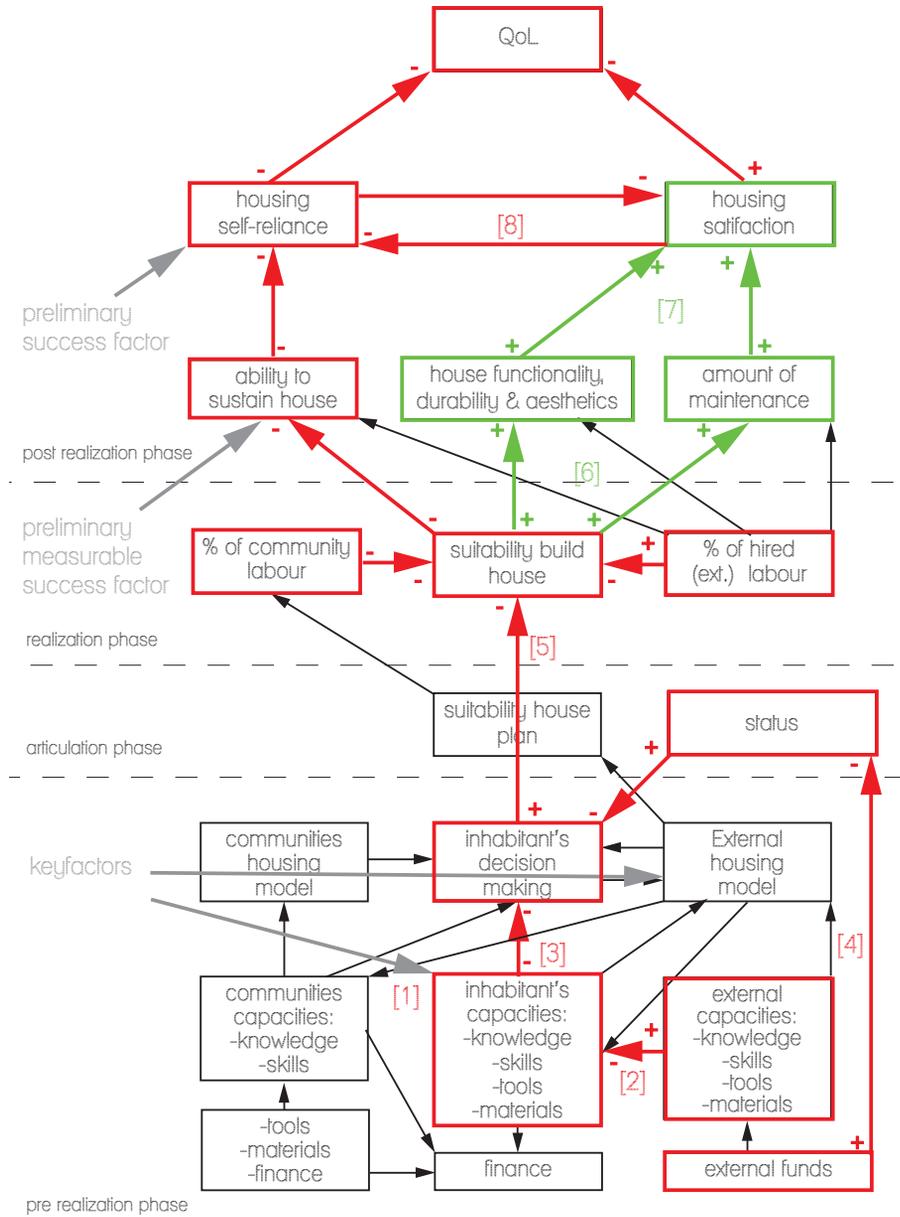


FIG. 6.35 Impact Model: control group (author, 2019)

This undoubtedly is one of the most problematic findings of this research. Inhabitant capacities are complex, and families do not always understand why certain solutions were chosen by their team. As the families made the final decisions, they somehow changed materials last minute. They were either not involved enough to understand certain decisions or simply rejected them based on their preferences (not based on their capacities). Moreover, they lack the background or experience to fully comprehend the consequences of their decisions and therefore choose certainty over uncertainty. New and untested solutions pose uncertainty and as they are in a vulnerable situation, forced them to choose known solutions which lie outside their capacities. Only one (out of five) family was able to comprehend the aim, approach, and solutions their team proposed. Which can be explained by the family's high level of education and income.

There are major concerns and much room for improvement, however the outcomes do indicate that the support has had a positive impact on the level of self-reliance of the support group families regarding their new housing. The control group confirm that their family mainly depends on external funds, materials, tools and skills, leading to a low level of the ability to sustain their house and increasing their vulnerability.

6.3.2 Findings Goal B in relation to research factors & key-components

The Prescriptive Study 1 addressed the design and framework to measure the support's suitability.

As previously mentioned, the support suitability depends on a multitude of factors. The composition of the team (professional or student), their level of education (Bachelor or Master), specialisation (engineer or designer), country of origin, and many more, correlate with the support's impact. As these (background) factors differed strongly between the applicants of the experiment, the support's suitability has to be perceived within this context. For this reason, the evaluation framework comprised of two parts.

The first part evaluated the support suitability for people with a different background: specialization, level of education, etc.

The applied evaluation framework (previous chapter) was designed to understand to which level the support was useful (specifically which parts), which parts must be altered, and which part were redundant. As the outcomes have shown many

chapters were found useful, although most of them require substantial revision. There were also chapters which were found redundant or need be combined. The outcomes indicate that the majority of the support was successful however, requires fundamental changes. As suggested before, within a consecutive research the support has to be redeveloped at tested again. This test needs to use the same framework and design, however also with some modifications (addressed in the recommendations).

The second part of the support suitability was evaluated through the impact model. The impact showed many similarities between the support groups (see Figure 6.36) and substantial difference in comparison to the control group (see Figure 6.36). Here, the support groups were able to include many of the existing inhabitant capacities which led to a high suitability of the articulated housing. The majority of the families have the knowledge, skills, tools and materials to sustain their house, even if their income diminishes (increased ability to sustain their house), which has resulted in a high level of self-reliance.

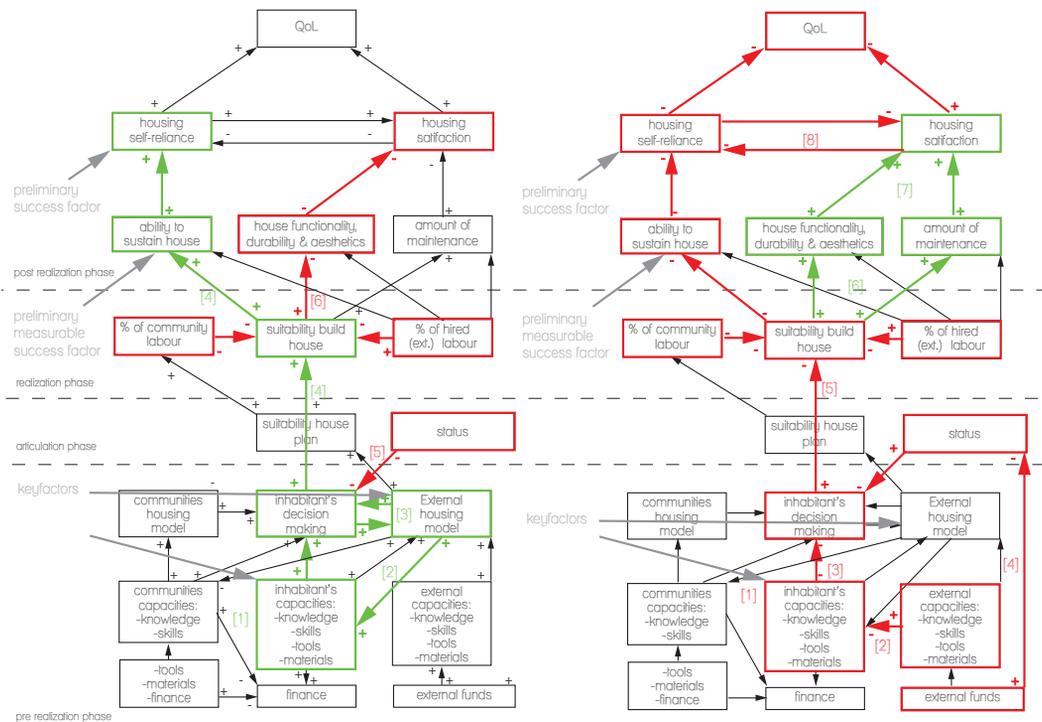


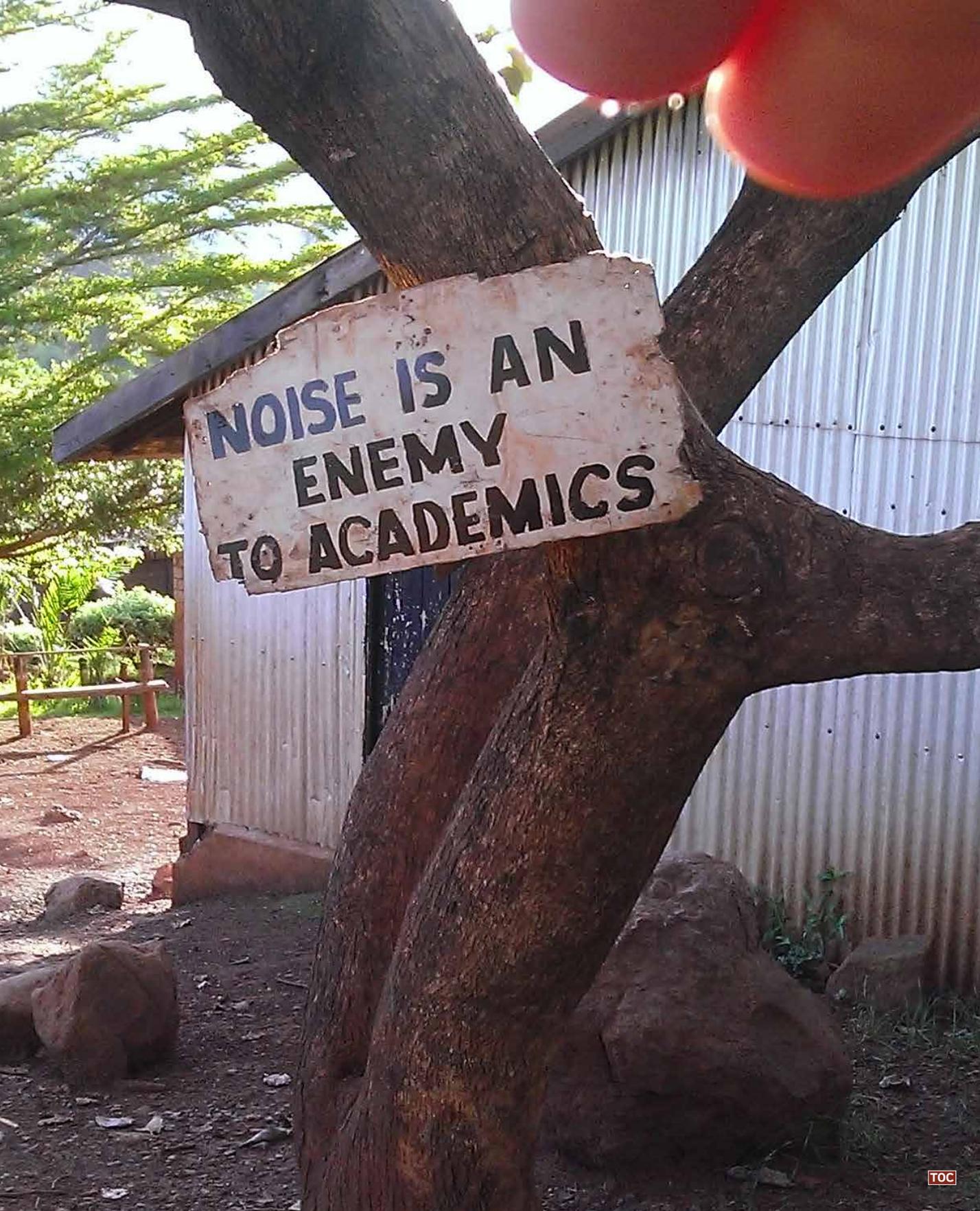
FIG. 6.36 Impact Model: support groups (left) versus control group (right) (author, 2019)

The control group, however, was unable to include the existing inhabitant capacities which led to a housing solution mainly comprising of external materials. Because the family largely depended on funds offered by the team this has tremendously influenced their decision-making process. Leading to a house that does suits their wishes but are not within their capacities. Although this reduces the amount of maintenance and increased their satisfaction, it decreased their ability to sustain the house. As they do not have the means, knowledge, tools or skills to sustain their house, this has dramatic consequences for the family's level of self-reliance.

Considering the sample size, the overall experiment constraints and previously mentioned correlated factors, the outcomes of this research indicate that the Support Tool has constituted to the increase of inhabitant self-reliance regarding their housing. Although it is unclear which parts of the Support Tool and experiment directly constituted to the suitability, three key-factors are certain: not offering funds to the family, emphasis on training the family in the introduced alternative house solution, and the presence of the teams. Although, none of support groups finished the houses their families will be able to finish the houses by themselves.





A photograph of a wooden sign nailed to a tree trunk. The sign is rectangular and has a rough, weathered appearance. The text on the sign is written in bold, black, sans-serif capital letters. The background shows a building with corrugated metal siding and some greenery.

**NOISE IS AN
ENEMY
TO ACADEMICS**

6.4 Research findings

Previously performed research and projects built on Mt. Elgon by the author were the departure point of this research project. In the introduction initial observations on Mt. Elgon were positioned in the global context of self-reliant rural housing development, showing the problems in both the inhabitants' and practitioners' inability to realize improved housing on Mt. Elgon, which the inhabitants could sustain without foreign aid. As the investigated problems were deeply rooted in practice, this research aimed to articulate and test design support. Therefore, an elaborate research strategy was described in the second chapter. Investigating how these problems can be studied, identified and confirmed in practice. More importantly, how possible solutions can be researched and integrated into appropriate support. Consecutively, testing the support in situ and evaluating its impact on the housing situation of the investigated families. This required the use of mixed methods in a complicated set of variables in situ, the DRM was identified as the most suitable framework.

Initial literature review, mapping, interviews, observations, a boardgame, and case studies helped to identify inhabitant capacities as the key factor to sustain their self-reliance in relation to their housing. However, the correlating factors were extremely complicated, and they changed considerably between traditional, current, and desired housing. The DRM provided with a suitable approach to identify these factors and organise them in reference models. Here, the past reference model helped to capture the traditional housing situation, with a high level of self-reliance, and identify contemporary housing problems in the current reference model. Consequently, identified the factors which required investigation and formulate appropriate research questions for this research project.

The DRM also posed challenges in this phase of the research. DRM focusses on the required steps, however, lacks appropriate examples to translate these into the context of a manuscript. For example, how the introduction relates to the research clarification or how the DRM needs to be integrated into the methodology section of a manuscript. As the introduction and methodology section are presented before the research clarification the book could elaborate more how this is properly structured. Moreover, were given examples (in the book) on DRM application framed in a western context, however, is its application in the context of rural Sub-Saharan Africa considerably more complicated. Furthermore, housing is not a uniform product or process which can simply be repeated. The socioeconomical situation in which the studied families live can differ or change drastically, posing immense research challenges.

Although the research clarification identified significant housing problems on Mt. Elgon, this insufficiently covered how the problems were perceived by the inhabitants and involved practitioners. Therefore, the first section of the descriptive study 1 presented an elaborate housing survey amongst two hundred families on Mt. Elgon. Providing insights on traditional, current and desired housing in four different local communities. The outcomes showed that the majority of inhabitants lived in traditional housing (with minor improvements) and had the means to sustain their house even if their income diminished. The contrary was the case of the desired housing, where the required resources and skills were not available and more importantly not affordable based on existing income levels.

Inhabitants stated that they would have considered affordable alternative housing solutions, although they do not know any available alternatives or how those can be applied. Confirming that the majority of inhabitants were incapable of realizing improved housing without hiring labour or buying external resources. Proving a disparity in existing inhabitant capacities and those required for desired housing. Although the survey could have had more depth (in relation to later conducted interviews in this research project), the outcomes are representative for the families living in the area, as confirmed in the impact measurement. The rich dataset can be used for a much broader investigation than this research project.

The second section of the descriptive study 1 investigated available support tools for practitioners to evaluate and incorporate inhabitant capacities in rural housing solutions. Although useful tools were found in operating and implementing housing solutions in rural communities, none of them specifically addressed inhabitant capacities. Confirming that practitioners did not have access to appropriate support tools to articulate alternative housing solutions based on inhabitant capacities. In the initial impact model, the preliminary key factors were identified and were used to describe to the necessary key-components of the support. Presenting which topics, the support needed to address and which parts of the found tools need be used. More importantly which parts were missing completely and needed to be developed for the new Support Tool.

This research project initially intended to include expert interviews to confirm the need for design support. The literature review would then have shown if such a Support Tool existed. However, it seemed very difficult to find appropriate practitioners, with experience in realising rural housing in Sub-Saharan, within the given resource and time of the research. Although several practitioners were interviewed, the outcomes were inconclusive and proved difficult to correlate. Two practitioners confirmed many of the raised concerns in this research, however, two other practitioners contradicted many of them. A focus group could have helped

to reach a consensus, however, was the idea was abandoned due to limited time and was left out from this research. It is of extreme importance that in a possible consecutive research, this part is included and possibly extended to reflect on suitability of the support. The literature review covered as many suitable support tools as possible however, was also limited to the available time. This might have excluded suitable support tools. The DRM and the description of the factors within an impact model, were extremely useful in understanding the studied phenomenon in practice. The established criteria helped to identify the key themes and made the literature review much easier to conduct.

A large part of the prescriptive study 1 was used to develop the key-components into chapters for the new Support Tool. Some of the chapters were based on existing tools where other had to be completely developed. For example, a framework for inhabitant capacities evaluation did yet not exist. The chapter therefore described a mapping approach, an interview, and observation method (including observation sheets where the support user can register found capacities).

Another example of a part developed from scratch of the Support Tool was the framework for inhabitant capacities integration into the design process. Here, the Support Tool user was advised to list all the tools, materials, and skills available at the family and in their community. Clearly stating if the resources are available at the family, if they can be borrowed from the community, or if they have to be bought. After the sketch designs for new housing were made, the user can then state which resources are required and make possible alternative solutions based on the inhabitants' capacities. Consequently, the support user would be able to present and discuss alternative housing with the family, deriving at a housing solution which will match the existing capacities and desired housing as much as possible. All the previously described components were put together in the: Rural Housing Support Tool.

In a quasi-experiment the articulated Support Tool was tested amongst four teams. During the experiment one key component was missing: the knowledge transfer between the support user and the family. This key-component was crucial in enabling the families to sustain their new house. Consequently, a chapter was added in the first weeks of the experiment. Outcomes of the experiment show that the majority of the selected families did not prefer housing solutions based on existing capacities and were not convinced by the teams' alternative solutions. For the families to better understand the problems surrounding the disparity between existing and desired housing solutions considerable alterations to support need to be made.

With the Support Tool described, the Prescriptive Study 1 continued by describing how the tool can be tested, designing the setting of the quasi-experiment. Describing how the community on Mt. Elgon was chosen, moreover it showed the selection process for the families and support teams, identifying selection criteria and choosing suitable sampling. The outcomes of the quasi-experiment exposed some flaws in the design of the experiment. Firstly, the chosen community was already further economically progressed than originally assumed. As a result, the expectations of the Support Tool users did not suit the reality of the family and caused confusion. In traditional housing the community members would help without financial compensation, in the experiment none of the community members would help without payment. Secondly, in the family selection process, a local social worker was used, he was later found living in the same community. There is evidence that all families knew the social worker personally and had an advantage in the application process. Causing unnecessary confusion and frustration within the community.

To find a balance in sufficient sample size (four teams) was difficult due to the severe financial constraints. As an effect, bachelor students and recent graduates (MSc) were selected for the experiment. This made certain passages of the Support Tool useful for the BSc students, however, found unnecessary by the professionals (recent graduates). Although this presented some downsides, it has enabled the application of the support to a broader audience. When looking at the competences of the involved team members it seems that the local architect had a tremendous advantage in language and knowledge on local building. Raising the concern that in future projects either only local professionals must participate, or local building knowledge has to be offered to non-local participants (possibly covered by local fundis).

Although the author's prior experiences on Mt. Elgon have provided many advantages in the overall research project, it is important to state they created limitations. The research project now focusses on the support of external professionals to advise and train local inhabitants. With a more thorough initial investigation local builders (fundis) could have been identified as the aim of the support. Here a multitude of approaches might have solved the inhabitants' inability to articulate alternative housing, by offering alternative materials or construction methods. As the author does not originate from the context of the studied phenomenon the conclusions show sociocultural misconceptions which could have been prevented.

The prescriptive study 1 followed by describing how the quasi-experiment was executed on Mt. Elgon. Mainly focussing, on how informed consent was achieved with the local government, community, families and teams. The most important part of

this section was the process of ethical approval by the TU Delft, Jomo Kenyatta and the Kenyan National Commission for Science, Technology and Innovation. Although all official procedures were followed, the outcomes of the quasi-experiment have only left one out of five families with a physical roof above their heads. Although the outcomes of the research are positive and the majority of families are satisfied (one is not), it does rise ethical concerns. All families kept their original house and therefore had a place to live, however, none of the families have finished their houses up to this date. Although they indicated that they have a high ability to finish their new house by themselves they lack the materials and financial capacities to do so. The quasi-experiment should have described an emergency plan to support the involved families in finishing their houses after the teams left. It would have been helpful if the DRM would have covered such ethical concerns conducting a quasi-experiment in situ.

The last sections of the Descriptive Study 1 described how the impact and suitability of the support was measured. In an in-depth interview cycle prior to the quasi-experiment all participating families reflected on their general capacities in relation to their former, current and desired housing. This cycle was repeated after the quasi-experiment to measure the impact of new housing in comparison to their former housing and correlated these to desired housing. The measurement provided detailed and accurate outcomes in the perception of the families. Although it is positive to perceive these improvements through their eyes it also has severe limitations. Training the families was sometimes problematic and therefore poses questions on their actual ability to maintain the house by themselves. Moreover, the reflection of the family and their team in a focus group would provide with a more fundamental understanding on the impact of the experiment. However, the timeframe did not allow elaborate evaluation methods with both the family and the team. Nonetheless, the initial reference model (DRM) helped identifying the key and success factors and measure them in the interview cycles.

To measure the suitability of the Support Tool the users wrote comments in the Support Tool during the quasi-experiment. After the quasi-experiment the users participated in an elaborate survey evaluating every chapter of the Support Tool. Outcomes of the research show that the moment of evaluation was highly problematic. Participants, especially practitioners, decreased their feedback the further they progressed in the Support Tool. This mainly happened because the Support Tool took too much time and obstructed the progress of the housing realization. Therefore, not all the chapters were used as instructed and therefore also have limited feedback.

The survey was conducted too soon after the project. The teams were exhausted, which has caused more negative and, in some cases, a more superficial response. As some of the chapters were used four months earlier the participants struggled to think of the main issues at that time. It would be advisable to make a detailed survey each time a team finishes a chapter and a generic survey at the end of the experiment. The support suitability was only used measured by its users, it would have helped if the inhabitants had discussed their perspective with their team. This might have increased the family's understanding how the support works and more importantly why some of the chapters were important although they took valuable time. Now most families found the Support Tool and connected research as a loss of time.



6.5 Overview of all answers to Research Questions & Overview DRM stages

One of the main findings of the Descriptive Study 2 is to provide an overview of all the research questions and subsequent answers. This section therefore describes all the research questions and answers, closing with a table that provides an overview of the research questions per phase.

RQ1: What are inhabitant's main contributors to self-reliant housing?

A.RQ1: The research clarification pinpointed communal organization as one of the main contributors to self-reliant housing. Indicating that without this regulation the spatial organization and living quality deteriorate and the inhabitants' self-reliance regarding their housing decreases. In the literature review of this chapter this phenomenon is describe through the spatial organization as an intrinsic part of a CoP and the way the community sustains their building knowledge. Pinpointing inhabitant capacities within HCT as the key-factors (financial capital, labour, resources, tools, knowledge and skills) for self-reliant housing. Therefore, communal organization and inhabitant capacities are identified as the most important contributors to inhabitant's self-reliance regarding their housing.

RQ2: Are inhabitants able to articulate desired self-reliant housing by themselves?

A.RQ2: Section 3.2 of the RC-phase, deployed mixed methods to understand the existing housing situation on Mt. Elgon. Investigating informal housing in detail on the level of everyday living activities and how these correlates with activities of other families within the community. It became apparent that the families are able to sustain their traditional housing. However, current housing development on Mt. Elgon indicates that this is not the type of housing desired by the families. When looking at the existing capacities of the families they will not be able to meet the required capacities for desired housing. Therefore, Mt. Elgon inhabitants are able to sustain traditional housing and have a high ability to sustain this type of housing. However, they lack the capacities to articulate desired housing and would not be able to sustain this housing when realised. Therefore, the inhabitants on Mt. Elgon are not able articulate desired self-reliant housing by themselves and require alternative housing solutions.

RQ3: Which factors hindered housing improvement?

A.RQ3: The majority of the interviewed households have more than sufficient capacities to build a house traditional house by themselves. However, it is clear that almost all households desire a different type of housing. Looking at what those preferences would require it is clear that there is a mismatch between what inhabitants currently have and what they desire. Inhabitants stated that they are unaware of alternative housing solutions that would meet their capacities and therefore require external help. Articulating such alternatives require a substantial knowledgebase. This makes the formulation of a possible alternative ‘desired’ house by the inhabitants themselves difficult. Integrating their current capacities into alternative solutions will play a vital role to its success and implementation. As shown in this study, considering alternative solutions that do not meet the inhabitants’ capacities is simply not viable (no mortgage loans available). Therefore, the factors that hindered housing improvement are the inhabitants are:

- Inhabitants do not want to continue traditional housing solutions that meet their existing capacities.
- Inhabitants lack the (mainly financial) capacities to afford desired housing
- Inhabitants lack the knowledge of the alternative solutions that meet both their desired housing as their existing capacities.

Improved housing is currently only accessible for inhabitants with high financial capacities. Additionally, inhabitants are increasingly excluded from the realization process of improved housing. Indicating that practitioners realizing improved housing on Mt. Elgon lack insufficiently consider existing capacities of the majority of inhabitants. The state-of-the-art analysis showed that a Support Tool addressing inhabitant capacities in the development of improved housing does not yet exist. Concluding that the preliminary key factors that hindered the realization of improved housing by the practitioners are:

RQ4: What are the necessary key-components of the Support Tool?

A.RQ4: Based on the state-of-the-art-analysis in the DS1-phase the following key-components (**K-C**) were identified:

- **K-C1** Key Topics: will address the main goal (self-reliance of inhabitants in relation to their housing), objectives and topics. This key-component is meant to increase understanding in the underlying motives and theories of the overall support.
- **K-C2:** Sensitive context approach: will explain the sensitivity of working in a vulnerable community. Elaborating on desirable: behaviour, documentation, clothing and such.

- **K-C3:** Daily routine interview: is meant to get a first understanding over every day activities of family members. Increases understanding of cultural and social differences, moreover, helps preparing of mapping and observations.
- **K-C4:** Dream-house-game: this key-component helps understanding the desires and preferences of the entire family. This will in a later phase be used to project the actual inhabitant capacities on.
- **K-C5:** Preparatory house and context mapping: explains how to make an extensive site survey. Starting with the general basics for people who never made such a survey. Later on, elaborating on specific elements that will need to be analysed in preparation for the capacity analysis.
- **K-C6:** Inhabitant capacity evaluation through observations: in addition to the context mapping an in-depth understanding of daily activities and spatial usage is needed. This key-component attributes the theories on observation and how this needs to be conducted in this type of context.
- **K-C7:** Context depth analysis: explains how to make an extensive site survey. Starting with the general basics for people who never made such a survey. Later on, elaborating on specific elements that will need to be analysed in preparation for the capacity analysis.
- **K-C8:** Inhabitant capacity evaluation through interviews: is the final step in getting a full understanding of all the existing capacities of inhabitants, relatives and community members. Compiling a list of all available skills, materials and tools.
- **K-C9:** Capacity-informed decision-making (gap: methodology does not exist): based on the identified capacities this key-component helps to articulate three design propositions and developing them with the family to a final design.
- **K-C10:** Planning with inhabitant capacities: with a project based on available capacities, most of the elements needed to construct the house will need to be collected, borrowed, harvested and such. This is a time-consuming effort unknown in regular project processes. This key-component will help to plan the activities and needed capacities.
- **K-C11:** Training & Effective knowledge transfer: knowledge transfer to the inhabitants is the most crucial factor in their ability to maintain, extend or replicate to offered solution (materials, construction and design). This key-component will help to register the existing skill levels and plan trainings accordingly on the job.
- **K-C12:** Observer role: daily change of roles between the team members, enable them to objectively analyse and adjust how they approach the project. This key-component will help register the team's progress and control if the actor uses the Support Tool accordingly.

RQ 5: What helps in approaching a vulnerable context?

A.RQ5: Firstly, by offering the user relevant background information on the importance of self-reliance in articulating sustainable housing. How self-reliance can contribute to the QoL of rural inhabitants in development countries, pinpointing collective intelligence as key factor in realizing sensitive and sustainable building solutions (**K-C1**). Secondly, by stating general misconceptions and possible sociocultural problems working with a vulnerable rural community in Sub-Saharan Africa. Especially practitioners who never worked in such contexts need to be informed on appropriate behaviour, clothing and approaches (**K-C2**). Thirdly, the observer can help to make sure that the actor makes the family comfortable participating in the daily activities, moreover, tracks the teams progress and adjust possible undesirable behaviour (**K-C12**).

RQ 6: How can inhabitant capacities regarding their built environment be evaluated?

A.RQ6: Inhabitant capacities can be evaluated through observations and interviews. Therefore, **K-C 3&8** provide the user with an interview cycle which helps family members to reflect in detail on all their capacities (everything they know and have). Moreover, which of those capacities lie within their community. However, some capacities unknowingly lie within their direct surroundings or everyday activities. For this reason, **K-C 5** helps the user to map, measure and draw the capacities in the physical context in which the family lives. This forms the basis for the observation described in **K-C 6**, where the user is able to register the position and circumstances in which the capacities are located or take place. As inhabitants are aware of what they desire but not always what they require, **K-C 4** enables the user to capture these requirements in a game setting. Moreover, are inhabitants not always aware of the community capacities they might have access to. Therefore, **K-C 7** helps the practitioner to analyse the capacities which can be found in the direct surroundings of the family compound.

RQ 7: How can inhabitant capacities within their built environment be integrated into housing solutions?

A.RQ7: **K-C3/4/5/6/7/8** helped the user to evaluate inhabitant capacities, however after conducting all these steps they are left with a complex set of capacities. Therefore, **K-C9** describes how these capacities can be categorised, quantified and in case of skills, describes their existing levels. Users can then use this capacity overview as the basis to develop concept building solutions on. Helping the user to ingrate as many of the existing capacities as possible. Moreover, choosing building solutions that are as close as possible to their existing knowledge and skill levels.

A major downside on borrowing tools, exchanging materials, or on volunteers, is the planning. Therefore, **K-C10** helps the user to make an overview per phase, which capacity is required when and by whom. As skills require training and therefore might be time consuming, the user will need to plan and spread these activities over the entire construction period. Enabling the user to generate a clear overview for the family when certain capacities are needed, and which activity is taking place. Securing that the family is in charge and control of all the required capacities.

As previously explained, during the experiment the users struggled to track inhabitant skill development. Therefore, **K-C11** was added which solely focussed on training the family skills in order to maintain, extend or replicate the house by themselves. Knowledge and skill are fundamental capacities to the level of self-reliance of the family regarding their housing. Therefore, training the family is vital in integrating their capacities in the housing solution.

RQ 8: How can the impact of the support be measured?

A.RQ8: As elaborated, multiple groups and perspectives could measure the impact of the support. One strongly emphasizes the professional point of view. Here, the user of the support would reflect on the articulated housing solution and to what extent this solution contributes to the inhabitant's self-reliance. Although this would enable in-depth understanding of the support application it would lack objectivity. An external observer would be able to reflect on the social, cultural or spatial impact on the inhabitant. This research emphasizes strongly on inhabitant capacities and as these are deeply rooted in everyday experience of the inhabitants, they are experts to reflect on the impact on them. Therefore, the inhabitants, although not practitioners, reflect on their housing situation before and after the experiment in a structured interview setting. In the interviews, the questions are formulated around the identified research factors. As the inhabitants reflect on past, desired and new housing a comparison can be made in the inhabitant's level of self-reliance in relation to these different housing typologies. Effectively measuring the impact of the support on the new housing in comparison to their former housing.

RQ 9: How can the suitability of the support be evaluated

Answer: As the field experiment in Kenya (2017) was the first time the Support Tool was used, an elaborate evaluation is needed to assess its applicability and overall suitability of the Support Tool. Here users are not asked to evaluate the impact of the support on the inhabitants, but to reflect what supported them in articulating improved housing for their family. To enable the user to make remarks and suggestions in the field, comment sections were added. These can then be used

to evaluate the suitability of individual chapters and lead to additions and alterations to the support. As the teams' time is very congested during the field experiment a second evaluation framework is needed after the experiment. In the survey the teams reflect on a detailed level on the support's suitability. In consecutive interviews the users reflect on the answers they gave and make corrections if needed. All outcomes together can be used in a consecutive research where an improved version of the support can be tested.

Overview of the DRM Stages

TABLE 6.3 Overview of the DRM Stages

DRM Stage	Research Question(s)	Goal
Research Clarification	RQ1	What are the main contributors to inhabitant's self-reliant housing? Problem identification Hypotheses and Measurable Success Criteria
	RQ2	Are inhabitants able to articulate desired housing by themselves? Addresses hypotheses 1,4,6 Answers RQ1+RQ2 Development of RQ3+RQ4
Descriptive Study 1	RQ3	Which factors hindered housing improvement? Problem is expressed in practice (inhabitant): - Desired housing solutions do not meet the existing capacities of the inhabitants Addresses hypotheses 2&3 - Inhabitants are unaware of alternative housing solutions that suit their capacities Addresses hypotheses 5&8 Answers RQ3
	RQ4	What are the necessary key-components of the design support? Problem is expressed in practice (practitioner) + key-components identification: - Sensitive approach to the context - Evaluating inhabitant capacities regarding their housing - Capacity based decision-making in housing solutions - Effective knowledge transfer Answers RQ4 Addresses hypotheses 7 Development of RQ -5-6-7-8-9

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TABLE 6.3 Overview of the DRM Stages

DRM Stage	Research Question(s)	Goal
Prescriptive Study 1	RQ5	What helps in approaching a vulnerable context? Goal A: Vulnerable context approach: Undesirable & desirable behaviour, appearance and communication Goal B: Vulnerable context methodology: Daily switching of actor & observer role
	RQ6	How can inhabitant capacities concerning their built environment be evaluated? Framework for inhabitant capacity evaluation: Mixed method (interviews, observations, games & context mapping)
	RQ7	How can inhabitant capacities regarding their built environment be integrated in solution formulation? Methodology for capacity informed decision-making.
	RQ8	How can the impact of the support be measured? Framework for impact measurable (success) criteria: - Baseline in-depth interviews with inhabitants - Impact in-depth interview with inhabitants and community members
	RQ9	How can the suitability of the support be evaluated? Goal A: Gathering written feedback from the participants on the support (2 rounds) Goal B: Evaluating the suitability of the support: - In-depth interviews with participants - Reflection control group on support (after project) Answers to: RQ-5-6-7-8-9 Development and testing of the Support Tool within quasi-experiment.
Descriptive Study 2	Test RC 1-9	Goal A: Evaluate support impact Goal B: Define the recommended adjustments to the support Verification of the Research Factors & Key-components Verification of hypotheses
Conclusions		

6.6 Overview of all answers to Hypotheses

Derived from the outcomes of the goals and the answers to the research questions, the hypotheses can be either denied or confirmed. Below an overview of all the hypotheses of this research project.

Hypothesis 1: Inhabitants are unable to articulate improved housing that they envisage without help

Both the outcomes of the household survey and the impact analysis (of the four families involved in the experiment), confirmed that the inhabitants of Mt. Elgon were unable to articulate affordable improved housing by themselves. Thus, confirming that Inhabitants were unable to articulate affordable improved housing without help.

Hypothesis 2: Inhabitants of Mt. Elgon prefer to continue building houses by themselves

In the household survey inhabitants indicated a high willingness to build desired housing by themselves. They answered that they would even help realize public buildings in order to learn improved building solutions. However, in the quasi-experiment the families contradicted themselves. Although in the baseline interviews the families stated that they prefer to build the house themselves (confirming hypothesis), given the option they would prefer someone to build the house for them. If the community continues to economically develop in the current pace, it seems highly unlikely that they will continue to build houses by themselves, hence denying that the inhabitants of Mt. Elgon prefer to continue building houses by themselves.

Hypothesis 3: Inhabitants of Mt. Elgon desire housing solutions that do not suit their capacities

The majority of the participating families have shown that they prefer non-local industrialized materials over local natural materials, even if these do not fit their capacities. Some of the families have taken loans or borrowed money during the experiment to buy materials which were not originally budgeted. Proving that in comparison to traditional or offered alternative solutions, they prefer to buy non-

local materials which do not meet their current capacities. Thus, confirming that inhabitants desire housing solutions that do not suit their capacities.

Hypothesis 4: Local skilled help is insufficiently able to articulate solutions based on inhabitant capacities

Although the local skilled help was not a part of the impact evaluation, observations have proven that local skilled help can either build traditionally- (mainly based on natural materials) or desired housing (mainly based on manufactured materials). Skilled local builders are unable to offer the studied families alternative housing solutions that would fit their current capacities (mainly financially). Confirming that local skilled help is unable to articulate solutions based on inhabitant capacities.

Hypothesis 5: Inhabitants of Mt. Elgon lack the knowledge to articulate alternative housing without external support

The baseline interviews of the experiment show that the studied families struggled to identify alternative materials and construction methods which meet their existing capacities. Moreover, the families answered that they require help to realize improved housing based on their existing (financial) capacities. Thus, confirming that the studied families lack the knowledge to articulate alternative housing matching their existing capacities, without external support.

Hypothesis 6: External skilled help (architects) are unable to articulate solutions based on inhabitant capacities

Literature review, case studies, past project interventions, as well as the outcomes of the control group, confirmed that without appropriate support the practitioners mainly apply external capacities (mainly funds, labour and materials). Past housing projects created a capacity disparity for the users to sustain their houses after realization. The research outcomes prove that the control group was unable to articulate a solution based on inhabitant capacities and that support groups were able to do so. Therefore, confirming the hypothesis.

However, the sample size of this research project is too small to make assumption about architect's in general. Moreover, were practitioners insufficiently involved to confirm the necessary components for a possible Support Tool. It remains

therefore inconclusive if practitioners are unable to articulate solutions based on inhabitant capacities.

Hypothesis 7: Currently no tools exist to evaluate inhabitant capacities and use these to articulate alternative housing solutions

Even though the literature review was limited, the tools and manuals evaluated in Descriptive Study 1 suggested that many tools developed for rural housing in development countries lacked a holistic approach to make a complete inventory of existing capacities (materials, tools, knowledge and skills). Moreover, that they miss practical guidance to use them in house design or realization. Confirming that no tools existed to evaluate inhabitant capacities and use these to articulate alternative housing solutions (hypothesis 7).

Hypothesis 8: Inhabitant capacities are essential in articulating housing solutions that nurture the self-reliance inhabitants have in relation to their housing

The outcomes of the experiment show that the main threshold for families to realize desired housing lies in their current capacities. After the experiment finished the control group family stated that they will not be able to maintain, extend or replicate the new house without help. The support groups however did show various levels of ability to maintain, extend or replicate the new house. Indicating that the teams using the Support Tool have realized a higher level of inhabitant self-reliance regarding their new housing. Hence, confirming that inhabitant capacities (through applied support) in this research project were important in articulating housing solutions that nurtures the self-reliance inhabitants have in relation to their housing.



6.7 The Technological Design: A practitioner's manual for sustaining inhabitant's self-reliance regarding their housing

In this section the model for the Rural Housing Studio (RHS) is presented, including the protocol for the Support Tool application within this model. Although this research project intended to articulate suitable design support, the context in which the support is tested and evaluated is an intrinsic part of the Technological Design. Therefore, the technological design reflects on the management protocol for the studio, the Support Tool protocol, and the impact measurement protocol. The model (Figure 6.37) is the organizational layout for the Rural Housing Studio as it was conducted in the pilot project on Mt. Elgon (2017). The model consists of the design for the six months lasting studio in which practitioners, students and participants participated. Not the entire organizational design of this studio is a fixed format in which the Support Tool can be applied, however, this developed organizational design provides with the minimal requirements. The organizational protocol, Support Tool protocol, and impact/suitability measurement protocol are specifically explained as they fundamental parts of the Support Tool application in situ, measure its impact and improve the support afterwards. In the scheme in Figure 6.37 the overview of the entire studio model is shown.

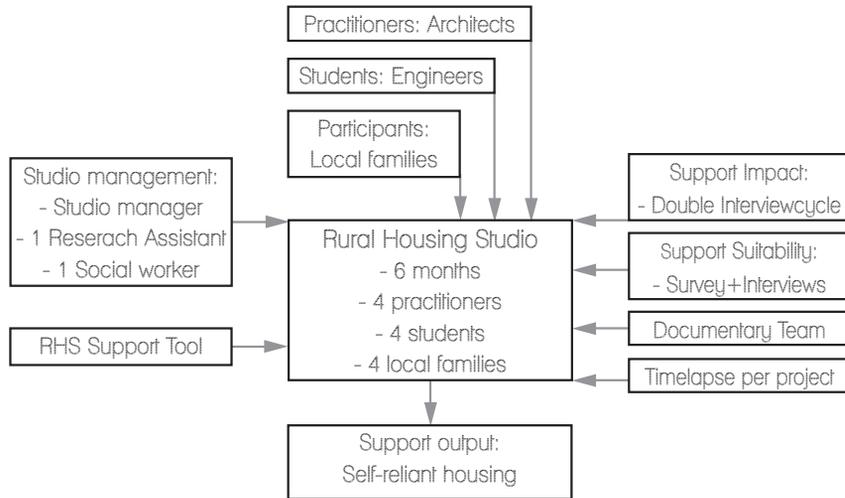


FIG. 6.37 The model for the Rural Housing Studio

Figure 6.38 shows the organization structure for executing the studio. In the next paragraphs, consecutively the organizing procedure, Support Tool protocol, impact measurement protocol and suitability measurement protocol are described. Part one describes the Rural Housing Studio protocol. Part two addresses the Support Tool protocol on how the Support Tool should be applied by the teams. Part three will elaborate how the impact and suitability protocols need to be applied by the studio manager.

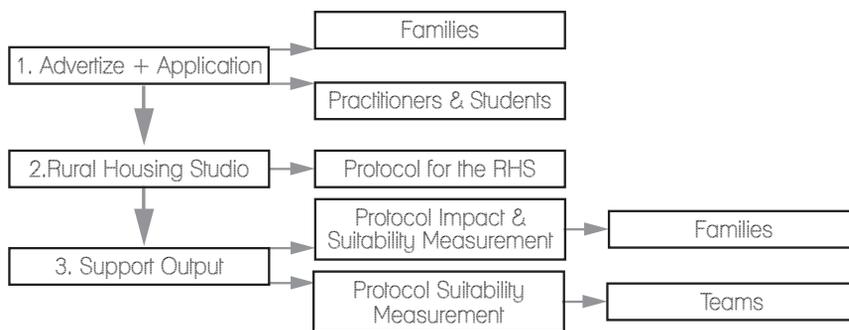


FIG. 6.38 Organizing structure for the Rural Housing Studio

6.7.1 Rural Housing Studio (RHS) protocol, Part One: Organizing the studio

To organize the Rural Housing Studio the next three steps need to be followed by the RHS Management. For more detailed information consult section 5.4:

- 1 Advertise the studio to practitioners in the field of architecture through LinkedIn and Social Media. The Advertisement should be entitled: *The Rural Housing Studio, housing for self-reliant families*. Due to the remote foreign location and possible international applications, start recruitment at least 9 months prior to the start of the studio.

Advertise the studio to engineering students from the built environment domain, through the university network (both physically through posters and digitally in their databases). The Advertisement should be entitled: *The Rural Housing Studio, housing for self-reliant families*. Due to a possible mismatch between the university's annual schedule and the studio planning, it is advisable to start recruitment 12 months prior to the start of the studio.

- 2 Submission for practitioners should be allowed if they have finished their master's degree in architecture. Moreover, having a strong motivation to work in the field of development aid is crucial and relevant working experience is preferred. Procedure: A GoogleForm was setup in which the practitioners could apply to the studio. Next the applicants received an e-mail confirmation and were requested to submit their c.v.'s and portfolios. After confirmation of the requirements a brief interview was conducted (online) to inquire the applicant's motivation and introduce the most important financial and organizational constraints (timeframe, available budget, the role of the RHS management and the responsibilities of the participants). It is important to inform the participant on: visa requirements, inoculations, and expected funds needed to participate in the studio (in the pilot studio the following things were covered for the practitioners: visa, flight, inoculations, and basic food/drinks). After accepting the practitioner, a contract needs to be offered which clearly states their responsibilities and must include a non-disclosure agreement (sharing anything of the process with other teams or third parties creates a possible research bias).

Submission for built environment students should be allowed if they finished the first two years of the bachelor curriculum and either apply for a third or fourth (graduation) year internship. Also, for the students a strong motivation to work in the field of development aid is important. The students followed the same procedure as the practitioners (see above paragraph). The student interviews need to

emphasize on the context they will work in, the possible dangers this poses and how they would cope in such dangers. It is important to inform the participants on: visa requirements, inoculations, and expected finance needed to participate in the studio (in the pilot studio students did not receive any financial compensation).

Submission for families should be allowed if they legally own a piece of land, if the family is available during the timeframe of the project, are able to communicate in English and have the funds and/or materials for a new house. The RHS management is in charge of gathering the family applications (preferably by a local social worker). After application the families have to be visited to explain the conditions of the project and the conditions of the contract (what can they expect from the RHS and what is expected from them). If the family is still interested, a short interview needs to be conducted (accompanied by a local social worker or village chief) to gather basic background information (amount of family members, ages, income, size of plot, etc.). Based on the interview outcomes the RHS management assess the following criteria: distance from the place of residence of the teams, available budget, condition of the existing house, availability of materials, labour and time. Some of these criteria are knockout criteria (family availability, already have improved housing, and language.) and other criteria can be used to locate the (four) families with the most similarities. The more similar the families are (especially in available budget and family size) the more comparable the outcomes of the studio will be. After the interviews the families need to receive an explanation on the studio contracts and need to be able to address any questions (it is important to emphasize what they should not expect from the studio: materials, tools, funds, etc.), afterwards the families are left with the contracts. In a final round the social worker needs to visit the family, inquire on any questions, and gather the signed contracts. After signing the contract, the families automatically joined the studio.

- 3 A minimum of 4 practitioners and 4 students is required to execute the Studio and be able to measure the impact. As the support consists of two roles (Actor and Observer) each team needs to consist of two members. The partnering of the team (one practitioner and one student) needs to be random sampled. One out of four teams is the control group and won't use the Support Tool, three teams will use the support. In case group-A has a positive impact and group-B+C have a negative impact, there is sufficient evidence that the support has the observed impact. The control group-D helps comparing outcomes with the groups that use the support and measure if the support had the desired impact.

A minimum of 4 families is required to execute the Studio and be able to measure the impact. Partnering the teams with the families also needs to be random sampled. The families were only introduced after the first week of the studio.

The following guidelines need to be followed by the RHS Management for executing the studio:

- 1 To conduct local quasi-experiments, elaborate ethical guidelines need to be followed according to your institution's legislation (if not available these have to be established to cover any legal or ethical issues). The following paragraphs explain the process of the executed pilot studio. Although these might not apply in every type of context they are recommended to follow, if not, just follow your institutional guidelines. In case of the pilot studio, the studio management followed the TU Delft code of ethics which is monitored by the Scientific Integrity Committee. This code included: establishing local partnership with a host university, writing an experiment proposal, formulation participant contracts (incl. consent forms), consent protocols & documents, media protocols & documents, and a communication plan. After both institutions approved all documents, the studio management can request the research permits at the local government.
- 2 The studio management needs to contact the country's research permit department and apply for individual research permits (if a participant is checked locally, they can always show the physical permit). After receiving the permits the local government (province) needs to be contacted and introduced to the studio (contacts can be obtained at the central government or permit department). In some countries (like the pilot studio: Kenya) local chiefs and village elders also need to be informed (when, where and whom) and requested access to the community. Informing local tribe members by the studio management will help to operate the studio smoothly and can prevent many problems or misunderstandings in the community.
- 3 When setting up the studio in a remote vulnerable community there is often a close social network in which the participating families live. Before contacting the families, the studio management needs to organise a community/neighbourhood meeting in which the studio aims and process are explained. Make sure that the management is accompanied by a social worker and if possible, by a chief or village elder (see previous paragraph). This will prevent envy in the community and makes them aware when and if their participation is required. Asking for an informal approval by the attendants creates a sense of inclusion.

- 4 With the local government and community informed the studio management can contact the families. As previously described (see step 2) the management needs to introduce the studio conditions, present the project consent form (see Appendix F) and audio-visual consent (see Appendix G). All the forms include a triple consent cycle according to the previously stated ethical guidelines, although the repetitive nature the studio management has to patiently go through all the conditions. The studio management needs provide the family with the forms and gives them 24 hours so consider joining the studio. When the family signed the forms, the management needs to approve the family's participation and send them the confirmation. Afterwards the studio management needs to conduct the baseline interview (see part 3 further on), preferably before the teams arrive.
- 5 As the teams will work remotely in a different sociocultural context it is vital that the studio management reserves one acclimatization week. In this week the teams can adjust to the climate, slowly discover the context they will work in, and prepare for their first days in the field (as described by support: 6.6.2). It is advised to give the teams some basic training on: local language, currency, prices (transport, food, materials & tools), desirable behaviour, and repeat the importance of the non-disclosure agreement for the accuracy of the studio's outcomes. The studio management is not allowed to tutor the teams at any moment during the studio as it will create a research bias.
- 6 A documentary team (Figure 6.37) was used in the pilot RHS as a secondary objective observation. This observation is not mandatory in executing the RHS however is recommended. In the first cycle, the documentary team spend 10 days interviewing the families, teams and community.
- 7 An extremely important factor for the studio is the teams' housing and office spaces. It is advised to separate the teams (living and working in entirely separate buildings prevent research bias), however, the teams will prefer to live together. For this reason, an additional meeting has to be organised to make the participants aware that they are not allowed to share their process with other teams or any third party. Although it is nearly impossible to prevent the teams from sharing, it is important to organise regular meetings (once a week) where the studio management makes the teams aware of the nondisclosure agreement.
- 8 As the participants make long days, often six days a week, and include hard physical labour it is recommended that the studio management also arranges cleaning, food and drinks. For this purpose, hire a local caretaker that makes sure that the teams can rest after a day in the field. Due to the remote location supplies will need to be brought in every week. It is appreciated by the participants if they can hand in personal shopping lists. In this way all shopping can be done at once.

- 9 The teams with support start their first day in the field according to the support (see: 6.6.2). The studio management is responsible to provide every team with: Gopro camera + charger, mini-SD card 64GB, 4 batteries, solar charger, photo camera + charger, SD-card 32GB and a waterproof bag. For the macro observation (see: Figure 6.39) every team needs to set the GoPro to the time-lapse function to make one picture of the team's activity every minute. The teams need to take the GoPro with them during every activity (walking, chatting, shopping, etc.) to provide with an overview of all the activities the team undertook during the studio. Enabling the studio management to monitor progress and compare the process between the teams. For the micro observation (see: Figure 6.39) every teams needs to use the photo camera to record interviews or to make detailed pictures (as described by the support). Recorded data can be used by the teams to transcribe and analyse their activities. The studio management can use this data to check if the team is conducting these activities according to the support. It is paramount that the studio regularly checks the team's progress, therefore it is advised to gather the data at the end of every week.

The control group will start on their own volition. To monitor and register their activities they were provided with the same equipment as the support groups. The studio management should instruct the control group on the macro observation (GoPro). The rest of the equipment they can use according to their own insight. Only the time-lapse would not be sufficient to register the activities of the team, therefore, an observer needs to be appointed that joins the team every day. Preferably this observer should have a master's degree in the social sciences or in architecture. The studio management will need to instruct the observer to register the following: team's activities, approaches, transcribing meetings & interviews, contradicting statements, mistakes, insensitivities and who was present on site every day. The studio management can use this data to compare the process with that of the support groups and identify important problems and solutions.

- 10 The teams will experience doubts, problems, or even emergencies. The studio management should organise a short meeting every week in which the teams can reflect on their situation. These are not feedback moments but merely meant to monitor the well-being of the teams (studio management is not allowed to tutor the teams at any moment during the studio as it will create a research bias). Keeping the teams motivated and healthy the studio management needs to regularly (once a month) organise leisure events. An afternoon to a local market, hiking in the area or a swim, help the teams to distance themselves from their working environment and relax. From this point of view the studio management should also stimulate the celebration of birthday or holidays together.

- 11 When a team completed their project the studio management needs to start the evaluation-cycle. Therefore, the families should be contacted on a suitable day to conduct the impact interview (see part 3 further on), preferably after the team left.
- 12 As explained at guideline 6, a documentary team was hired in the pilot RHS as a secondary observation. This observation is not mandatory in executing the RHS, however is recommended. In the second cycle, the documentary team spend 10 days interviewing the families, teams and community after the completion of the project. The documentary is not part of the impact measurement of the studio and is only used to promote the concept for future studios.

6.7.2 **Rural Housing Studio protocol, Part two: Support Tool protocol**

For the support teams to execute the Rural Housing Studio, the next 13 steps need to be followed (see Figure 6.39). It is of vital importance that the studio management regularly checks if the teams are executing the support according to the Support Tool (see Appendix E). For more detailed information consult on the key-components consult the Prescriptive Study 1.

As previously stated, there is not a fixed timeframe for the studio. The Support Tool users should be allowed to use the support according to their own insights. However, the support teams must execute chapters 4 to 13. The following table indicates the general minimal time schedule for the studio.

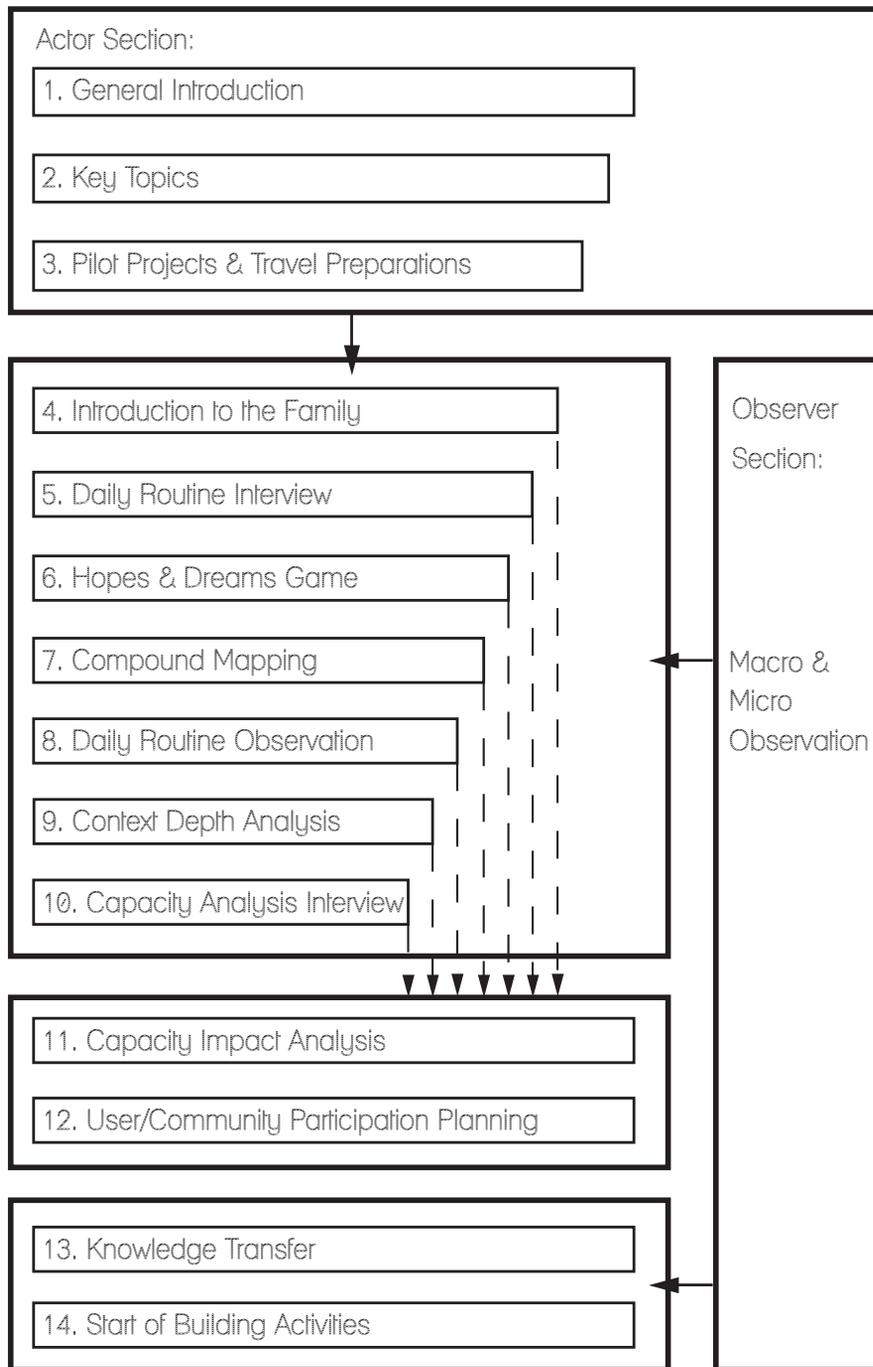


FIG. 6.39 Structure of the support

TABLE 6.4 Program of the Rural Housing Studio

Activity	Day	Week
Key Topics	Prior	
Pilot Projects & travel preparations	Prior	
Before Pilot		
Acclimatization week	1/2/3/4/5/6/7	1
Introduction to the family	8	2
Daily routine interview	9/10/11	
Hopes & dreams game	12/13	
Sunday feedback + data transfer	14	
Compound mapping	15/16/17/18	3
Daily routine observation	19/20	
Sunday feedback + data transfer	21	
Context depth analysis	22/23/24	4
Capacity analysis interview	25/26/27/29/30	
Sunday feedback + data transfer	28	
Capacity impact analysis	31/32/33	5
User/community participation planning	34/36	
Sunday feedback + data transfer	35	
Start of construction: every Sunday feedback + data transfer		
Foundation Phase		6/7/8
Floor		9/10
Walls		11/12/13/14/15
Roof		16/17/18/19
Finishes		20/21/22

The Support Tool (see Appendix E) provides with an elaborate step-by-step manual for the user to follow. The user agrees that by participating in the Rural Housing Studio they will execute the project according to the Support Tool. The protocol of this section will provide with an overview of the main steps (chapters) the user needs to take and the required output (behaviour, tasks and results), the underlined sections require actions from the management team. The user:

Introduction

- grasps the main goals of the Support Tool, the assignment location and the responsibilities for both the actor and observer role.
- understands why a changing actor/observer role is required and can state the advantages. The team agrees to change their roles every day and prepare daily

activities the day before. To track individual observations the user agrees to purchase a dummy. The user will write or sketch important observations in the dummy while being in the field or working in the office, registering and developing ideas or work on specific solutions. Although the dummy is not checked by the studio management, the user understands the importance of tracking their personal process.

- reads the support in detail and addresses any error or improvement in the feedback per page and at the end of the chapter. Moreover, the user fully understands the coding instructions and makes sure that all gathered data is digitalized (images, video, documents, etc.), coded, and organised in folders per chapter of the Support Tool. The user will make sure that all collected data is ready to be transferred on a fixed day in the week (set by the RHS Management). This data is well structured in folders per phase and are the files coded according to given instructions.

Key Topics

- confirms that even though having experience in development aid, reading the key-topics is important. The user understands the position that the Support Tool and the studio take in the field of development aid. Furthermore, grasps when and how the support constitutes to field of sustainable development. Moreover, understands the various development frameworks, knows which framework the support tools targets and how. Can relate this framework to the larger field of development aid, the necessity for self-reliant development and the role of the Support Tool. The user knows the WHOQOL indicators and understands which factors the Support Tool targets.
- grasps the concepts of collective, embedded and situated learning, moreover, can explain how these concepts can be observed in every-day life activities. Moreover, comprehends the concept of capacity-based development in relation to the Support Tool. The user is aware that the tool does not offer practical information for climatological house design, detailed soil testing, technical engineering and such. Consequently, the user will take the appropriate actions to gain this information prior to departure or is able to access this information during the studio. The user is requested to read the advised literature per subsection, however, is not mandatory. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool, which will then be handed over to the studio management.

Pilot projects & Travel preparations

- knows that although having some or little experience in conducting and transcribing interviews, is required to transcribe one interview (video recorded) of at least 30 minutes (pilot 1), provided by the studio management. The user will read and use

both the interview guidelines and -guide as offered by the Support Tool (see the Support Tool's digital tools: Appendix E). Resulting in a full transcription to be shared with the studio management. Consequently, the user has enough knowledge and training in conducting interviews independently. Users that do have experience in conducting interviews are requested to read all the documents to confirm if they have the necessary knowledge and make sure that they follow the same layout.

- must complete pilot 2 (see the Support Tool's digital tools: Appendix E) providing with an observation training using digital media equipment. Consequently, the user knows how to operate the observation equipment, how to save battery usage, prevent overheating, the required image quality settings, which types of protective casing there are and when to use them. Moreover, how to set a Field of View (FoV) in observing activities of their own choosing, focussing on both macro (GoPro) and micro (photo camera) observations. The user knows which effects the distance of the equipment has when recording the subject, how the number of frames per second relate to the level of detail and the size of the recorded data, also how sun exposure influences the quality of the observation. The user has tested their observation skills by observing a process in their own daily lives. Consequently, have experimented with all the previously mentioned variables. The user has coded all the gathered data according to the data protocol. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Actor Section

Chapter 1, Introduction to the family:

- is aware how clothing and behaviour influence the community and family they visit. Working in a different culture and level of income, the user anticipates how family/ community members might behave differently whilst in their presence. The user dresses appropriately, behaves patiently and is cautious, moreover, is respectful towards the local customs and traditions. The user identifies a convenient day to meet the family and makes all the necessary preparations. The user introduces their own background (place of residence & family) and asks the family questions about their background. The user explains and shows photos from their school (student) or from their professional (practitioners) life. The user is eager to learn more about the line of work the parents have or the studies of the children. The user asks if any of the family members would like to know more or have any questions.
- introduces the aim of the rural housing studio to the family, explaining and showing (see Appendix E) the disadvantages & advantages of both vernacular and modern housing. Referring to the images in the Support Tool and actively engaging the family

in a discussion about their housing. Moreover, inquire if the family understands and agrees on the aim of the studio and if they gave suggestions or questions.

- explains the various activities of the team while being with the family. Elaborating on the daily changing roles (actor/observer) of the team members, elaborating on the differences in roles, how the changing role can be identified and what is expected from the family. The user shows and explains why they write or sketch while being with the family. Moreover, how the different cameras work, where they will be placed and how the recorded data is stored.
- uses the provided checklist at the end of the chapter to gather all the necessary chapter requirements prior to departure. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 2, Daily routine interview:

- understands that their presence and line of questions in an interview can make the family uncomfortable. The user is aware of differences in cultural norms and executes the interview with as little intrusion and discomfort to the family as possible. Moreover, prepares questions on the daily routine of the family members and can explain per question why they need this information to articulate improved housing. Depending on the type of question and the addressed person, the user decides the location and composition of the interview. Protecting the privacy of the individual family members.
- uses the example interview manuals and guides provided in the appendices of the Support Tool (see Appendix E) to prepare the instructions and guides for their own interviews. During the interviews the user makes sure that there are sufficient breaks and that the interviewees are comfortable. Based on the interview outcomes the user understands all daily activities of the individual family members. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 3, Hopes and dreams game:

- understands the importance for individual family members to freely express their perspectives in relation to current and desired (dream) housing. Priory gathers all required materials and tools for both the drawing and modelling workshops. Moreover, plans an appropriate location to conduct the workshops individually.
- follows the specific instructions for the workshops and makes sure that all family members have individually expressed/addressed per house (current & dream) what they like about the house, what they do not like and what they would like to improve.

- follows the specific instructions for the exposition of all the gathered drawing, models and perspectives of the family. The user makes sure that all issues raised by the individual family members are discussed with the entire family, while walking through the exposition. The user uses the outcomes of this chapter to list and prioritise all the raised issues by the family. Creating a program of requirements of all problems and possible solutions which the user needs address in the design process for new housing. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 4, Compound mapping:

- grasps the fundamental difference between mapping regular commercial projects and in aid projects. The user understands that the various house functions (bathing, cooking, etc.) are scattered over a large area surrounding the house. To map the structures and places of importance in the area, the user gets all listed materials and tools (see Appendix E) prior to departure. The user uses all previously gathered information (daily routine & positive/negative aspects on current housing) to physically locate where and how these activities take place.
- maps all the individual structures of the family compound and draws the floorplan, sections and facades per structure. In both the floorplans and sections, the user clearly registers how the interior is used, if there is anything unclear the user inquires the family members. The full inventory is digitalized by the user in Sketchup. The user maps the entire family compound registering all physical elements, which is also digitalized in Sketchup.
- maps the following elements in a 500-meter radius around the compound: borders, fences, trees, rivers, water points, roads and places of interest. While mapping the user engages the community where necessary. The map and full inventory are digitalized by the user in Photoshop or equivalent program. Consequently, the user locates where specific activities of the family takes place and how these relate to the community. The user has now located how and where the family's housing problems and inconveniences are caused. Moreover, has a general idea where community capacities can be found for the new housing. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 5, Daily routine observation:

- understands the importance of conducting observations to relate previous chapter outcomes to the daily house usage of the family. The user watches the instructed video (Kitchen Stories), writes notes based on provided questions, and discusses these with their team member. The user knows what constitutes to an objective

observation and describes the preferred observation for observing their family in situ. The user gathers all the necessary requirements stated in the checklist prior to departure.

- informs the family why 24-hour observations are required to provide with suitable housing solutions and plans the various days for the individual family members. The user observes the family members individually and registers how the family uses their housing in the provided observation sheet (see the Support Tool's digital tools: Appendix E). Moreover, registers the activities which take place in the surroundings of the family compound and who they involve. The user gathers all the information from the observation in the observation sheets. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 6, Context depth analysis:

- grasps the necessity of a context depth analysis in relation to earlier chapters. The user combines the outcomes of the daily routine interview, compound mapping, and observations in one detailed map. In this map the user registers where the previously found materials, tools and labour can be found in the community. Special attention is paid to where community members live that would like to help the family in realizing improved housing. Moreover, the user makes an inventory of existing housing solutions by mapping the various typologies in the area.
- is aware that based on the family's limited budget the use of local natural available materials is of great importance. Consequently, the user registers all of the found resources and services in the area and if possible, test the composition and strength of the materials. Moreover, maps where public activities take place which might provide volunteers during constructing the new housing (church communities often help families). The user studies all geographical factors and makes a list of climatological conditions. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 7, Capacity analysis interview:

- understands that the ownership and availability of all previously found capacities are unknown. For this purpose, the user lists all the found capacities (resources, tools, skills and labour) indicating on earlier made maps where these can be found.
- develops an interview guide which addresses all factors addressed in the support and found capacities by the user, moreover, inquires if the family has any additions. The user plans a convenient moment for the family and conducts the interview. All capacities are registered during the interview by the user in the interview answer

sheet (see the Support Tool's digital tools: Appendix E) and transcribed according to earlier described guidelines.

- understands that all community capacities, which are not owned by family will need to be confirmed by their owners (community members). Therefore, the user develops interview guides to conduct semi-structured interviews with individual community members. Walking through the community, the user interviews as many of the listed community members as possible. It is advised that the user asks one family member to join the interviews. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 8, Capacity impact analysis:

- reads the building methods for local modern and traditional housing, consequently, can describe their construction processes. Based on the gathered capacities from the previous chapter the user describes three possible solutions per building phase: foundation, floor, walls, roof and finishes, in the provided calculation model (see the Support Tool's digital tools: Appendix E). The user formulates one housing solution solely working with available capacities (improved traditional housing), one largely depending on bought capacities (family's desired housing) and one solution which mediates between the two. Therefore, per possible solution the user describes different materials and tools. Of every solution the user makes one visualization or sketch in which the differences are clearly visible.
- repeats the importance of using existing capacities in building a new house to the family, followed by a presentation of the three housing solutions. In the presentation the user shows the desired housing design and elaborates on the required capacities. Clearly stating the capacities, the family has and lacks in realizing desired housing. The user repeats this process for the other two housing solutions.
- gives the family the opportunity to address all their questions on the three housing solutions. Although this is in the form of an informal interview the user records and transcribes this session. Based on the interview outcomes the user gathers the family's positive and negative feedback of the housing solutions. Together with the family, the user goes through the calculation model (see the Support Tool's digital tools: Appendix E) and discusses which specific materials they can afford. Based on these outcomes the user makes a design proposal including the preferences of the family, however mainly staying within their available capacities as much as possible. The required capacities are calculated and registered in the calculation model. After the family approves the solution the chapter is complete and will the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 9, User/community participation planning:

- is aware that building with borrowed tools and locally gathered materials, is time consuming and complicated. Therefore, the user makes a planning stating all the tools, materials and people needed per phase. The user discusses the final design, planning and required capacities with the family and makes adjustments if needed. After approval by the family, the user presents the design and planning to both the family and all involved community members. Afterwards the user places the planning on a visible location for both the family and community, informing them when certain materials, tools and labour are needed, in which quantities and from whom these are coming. The user helps the family in making a logbook in which all the materials, tools and labour are traced. The user checks this logbook regularly to make sure the project remains within the set timeframe and existing capacities of the family. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Chapter 10, Knowledge transfer:

- understands that knowledge and skills are the most fundamental capacities for the family and community in order to sustain, extend or replicate the new house by themselves. Based on the previous chapter the user knows which task is needed in each phase of the building process. In the effective knowledge transfer file (see the Support Tool's digital tools: Appendix E), the user disseminates these main tasks into smaller practical steps. Per step the user states the skills required to perform this task. The user understands the various skill levels and can describe per task what these skill levels contain. Based on the user's own building experience the required skill level per task can be identified. From previous chapters the user estimates the existing skill level of the family.
- understands the literature on effective knowledge dissemination through various learning methods. Consequently, identifies per task which learning method to start with and those needed afterwards in order to train the family to the required skill level for the task. After completing the effective knowledge transfer file (see the Support Tool's digital tools: Appendix E), the user makes a planning per week for train the families during the construction of the house. These activities are then registered, observed and monitored by the user in the registration of the training file (see the Support Tool's digital tools: Appendix E). The user is responsible to make sure that the family and community have the required skills to perform the majority of the tasks required to sustain the realized housing. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

Observer Section

- understands the importance of changing roles daily between observer and actor. The user comprehends different forms of feedback and applies these during the project, following the steps as described in the support. Based on the experience gained in Pilot 2 prior to departure, the user knows where and how to make digital observations.
- makes sure that all equipment is charged and ready to be used in the field the next day. The user takes all equipment to the working site and makes sure that the macro observation is set on the agreed location. During the day the observer makes sure that the GoPro is constantly on and changes batteries when needed. Based on the activity of that day, the observer makes either photos or videos with the photo camera of every activity according to the micro-observation instruction. The observer codes all digital data of that day and places the data in the appropriate folder.
- observes and registers the activities of the actor in the offered observation registration file (see USB-stick Appendix E). Here the user states: time, activity, duration, family's well-being, style of work, support fulfilment, comments and pictures. The user changes the criteria in the file according to the chapter that is being executed that day. During lunch or when the day is finished the user provides the actor with feedback on the activities performed and registers the decisions or adjustments made. When the day is finished the user digitalizes the sheet and places pictures or sketches of the observation in the file and makes sure the entire observation is complete. After completing the chapter, the user makes pictures of all feedback pages of the Support Tool. The chapter feedback including all the chapter's listed outcomes & data are handed over to the studio management.

6.7.3 Impact & Suitability measurement protocol

As previously stated the impact and suitability measurement protocol is part of the rural housing studio management protocol (section, 6.6.1, step 4 & 10) and therefore executed by the RHS Management. Due to the high complexity of preparing, executing and measuring the support's impact and suitability, this section describes the protocol in which both procedures have to be executed.

Impact protocol

The studio aims to articulate improved housing for rural inhabitants in developing countries. The crucial factor in realizing improved housing for them is to simultaneously sustain or increase their self-reliance regarding this realized housing. Enabling the inhabitants to maintain, extend or replicate their improved housing without depending on help. This crucial factor amongst many other correlating factors is the focal point of the impact measurement described in this section.

- 1 Before an actual impact can be measured the studio management first has to understand the existing housing situation. In the baseline measurement the studio management analyses what the level of self-reliance is regarding the family's current housing and compares these to their desired housing. In this way the studio management evaluates the existing housing situation and is therefore called the baseline measurement. The studio management has to make sure this measurement is performed before the teams arrive at the location.

To measure the impact of the support, a second measurement has to be performed to evaluate family's level of self-reliance regarding the new housing resulting from the studio. Therefore, the interview also reevaluates their opinion on former and desired housing. In this way the studio management evaluates the impact of the new housing situation and is therefore called the impact measurement. The studio management has to make sure this measurement is performed after the teams left the location.

To understand and compare current, desired and new housing, in-depth interviews need to be conducted by the studio management. To conduct these interviews, the studio management has to prepare interview questions according to identified factors in the reference model (Figure 6.40) and develop interview guides. In Appendix H the studio management can find the questions and interview guide for the baseline interview and in Appendix I & Appendix J the guides for the impact interview.

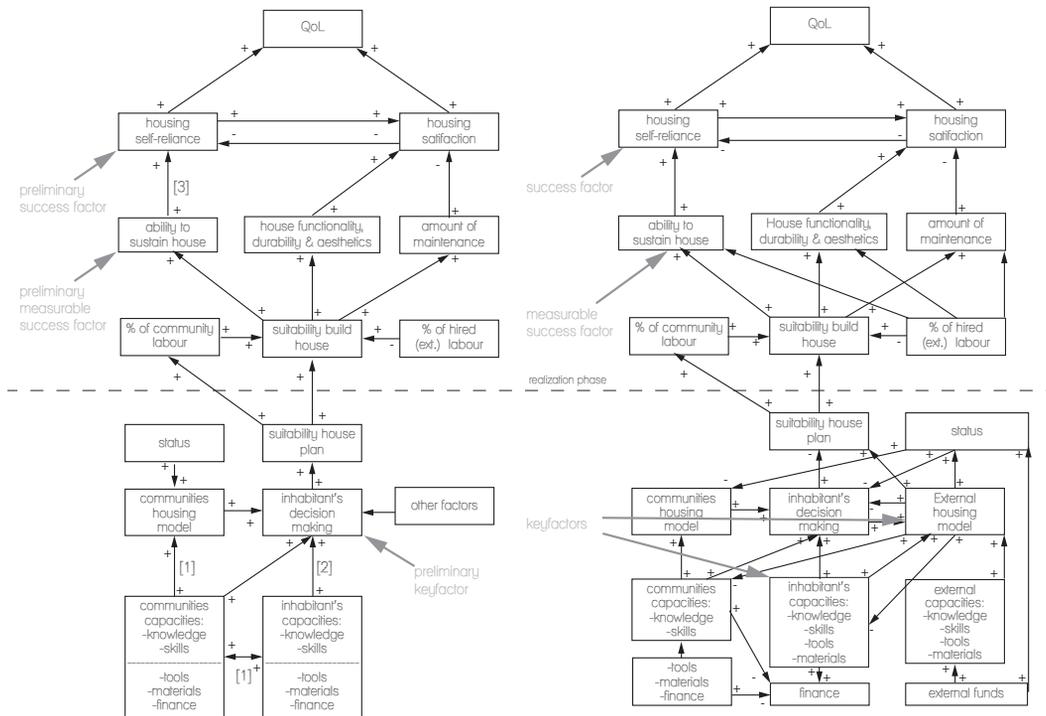


FIG. 6.40 left: past reference model, right: current reference model

- 2 The studio management can adjust the questions if needed, however, needs to make sure that the majority of the questions are repeated in the various sections of the interview (current, desired and new housing). When removing questions, the studio management has to make sure that all factors are sufficiently covered by the research questions. To help establishing an overview, the factors are numbered (Table 10) and divided into three categories: Community (C), Inhabitant (I) and External (E) factors.

TABLE 6.5 Current Reference Model including preliminary criteria.

I	C	Tools/Materials/Finance
II	I	Finance
III	E	External Funds
IV	C	Communities' capacities
V	I	Inhabitant's capacities: knowledge/skills/tools/materials
VI	E	External capacities: knowledge/skills/tools/materials
VII	C	Communities' housing model
VIII	I	Inhabitant's decision making
IX	E	External housing model
X	I	Suitability house plan
XI		Status
XII	C	% of community labour
XIII	I	Suitability of the built house
XIV	E	% of hired (external) labour
XV	I	Ability to sustain house
XVI	I	House functionality durability & Aesthetics
XVII	I	Amount of maintenance
XVIII	I	Housing self-reliance
XIX	I	Housing satisfaction

Related factor 1	Related factor 2	Question nr. Current Housing	Related Question Desired Housing	Related Question New Housing	Interview Question
BASELINE INTERVIEW QUESTIONS ON CURRENT HOUSING					
XIII	XVIII	1	nvi		Do you own the house you live in?
II		1a		51b&56	how is it financed?/did you need a loan, did you have savings
III		1b			how is it financed? Rental?
XVI	XIX	2			Does your house consists of one building or more?
XVI	XIX	3		53	What is/are the sizes of buildings? (meters or feet)
XVI	XIX	4		54	How many rooms does the house have?
XVI	XIX	5		55	Is the house large enough for the whole family?
XVI	XIX	5a			can you explain why?
XVI	XIX	5b		55a	can you explain why not?
V	XVIII	6			Do you own the plot?
V	VIII	7	75	60	What materials did you use to build the house? (please list material per phase: foundations, floor, walls, roof, finishes)
		8			In case the family has iron sheets:
XVI		8a			How does the iron sheet roof behave when it rains?
XVI		8b			What is the temperature inside during the midday under the iron sheet roof?
II		8c			How much did the iron sheet roof cost?
VIII	II	8d			Was it expensive?
VIII		8d1			if yes: Are there cheaper alternatives for roof material?
VIII		8d1a			if yes" I) Which are they?
XVI	VIII	8d1b			How do they behave when it rains?
XVI	VIII	8d1c			How do they behave in full sun?

FIG. 6.41 Example of linking research questions to reference model factors

To generate an overview, the studio management has to make one file (see Figure 6.41) in which all the questions are labelled according to their factor(s) and to the questions in other sections. The complete overview of the pilot project can be found in Appendix L. After the final question adjustments have been made the studio management has to update the interview guides accordingly. In Appendix H the studio management can find the guide for the baseline interview and in Appendix I & Appendix J the guides for the impact interview.

- 3 To conduct both interview-cycles (baseline & impact) the studio management must hire a local social worker and an observer. The social worker will make sure that the family is comfortable and offers assistance if any questions or discomfort arise during the interview. The observer makes sure that both video and a separate audio recording are made during the interview. Moreover, registers formulated answers to the questions by the family and keeps track if all questions are answered. The observer also advises the studio management if the family does not answer truthfully, contradicts themselves or show anxiety.

The social worker must have the appropriate local licences, preferably has experience conducting interviews (not influencing the interviewees), has worked with local NGOs before, is a proficient English speaker and preferably knows the locality in which the studio is conducted. The observer must have at least a master's degree in social sciences or architecture, has experience in observing, and is a proficient English speaker.

- 4 Before conducting the baseline interviews, the studio management contacts the families and sets convenient dates. These dates have to be confirmed by the social worker and observer. The studio management makes sure that the interview guide is printed before the interview and all equipment is charged.

As the baseline interview follows the contract meeting (section, 6.6.1, step 4) the studio management only has to introduce the observer to the family. Next the studio management will read the complete interview guide to the family. It is important to state that for the accuracy of the measurement all questions have to be repeated exactly the same between all families. The observer can only start placing recording equipment after the first paragraph of the introduction is read to the family and approved. When both video and audio devices are running the studio management can continue the rest of the interview. During the interview the social worker will make sure that the family gets sufficient time to answer the questions and help clarify things if needed. The observer makes sure that the interviewer does not divert

from the interview guide and helps keep track of the interview progress. For more elaborate task description see the previous step 3.

When all questions are addressed the observer stops the audio recording. To close the interview the studio management reads the consent section to the family and asks them if they agree to sign it. The overall consent for the studio is covered in the studio contract and subsequent consent (see section 6.7.1), however, the interview might contain details the family prefers not to share. Therefore, the studio management has to make sure that the family feels comfortable to share the interview outcomes.

During the studio the management is responsible to transcribe all the interviews. The management follows the same methodology described in pilot 1 (see USB-stick Appendix E, actor: chapter 3). Are transcriptions are completed the studio management asks the observer to check all the transcriptions for accuracy. The disadvantage of transcriptions is the lack of overview; therefore, the studio management has to generate an excel-overview of all the answers. Clearly stating the relation between the: questions, housing type (current, desired & new), reference model factor, the relation to other questions and the answers per family (support versus control group). In Appendix O the studio management can find an example.

- 5 To conduct the impact interviews the same procedure has to be followed as the baseline interview (see step 4). There is however one important addition the studio management has to take into account. For the impact interviews two guides will need to be developed: one guide for the support groups (see Appendix I) and one guide for the control group (see Appendix J). In developing the guide for the control group, it is important that the studio management replaces the questions which specifically evaluate the support. In their place the studio management articulates open questions in which the family tries to recapture the process and outcomes of their team.
- 6 With all the interviews transcribed and captured in one excel file (Appendix O), the studio management can start evaluating the impact of the support. The studio management should start by addressing the factors from the bottom of the reference model (see Figure 6.42) upward. In that way the impact analysis starts with the phase where a housing project normally also would start (list of requirements, design brief, etc.). underlying factors and relate them to the various building phases. To understand the difference between the family (Figure 6.42, nr1), community (Figure 6.42, nr2) and external capacities (Figure 6.42, nr3) the pre-realization phase is divided in these three groups (I, II & III).

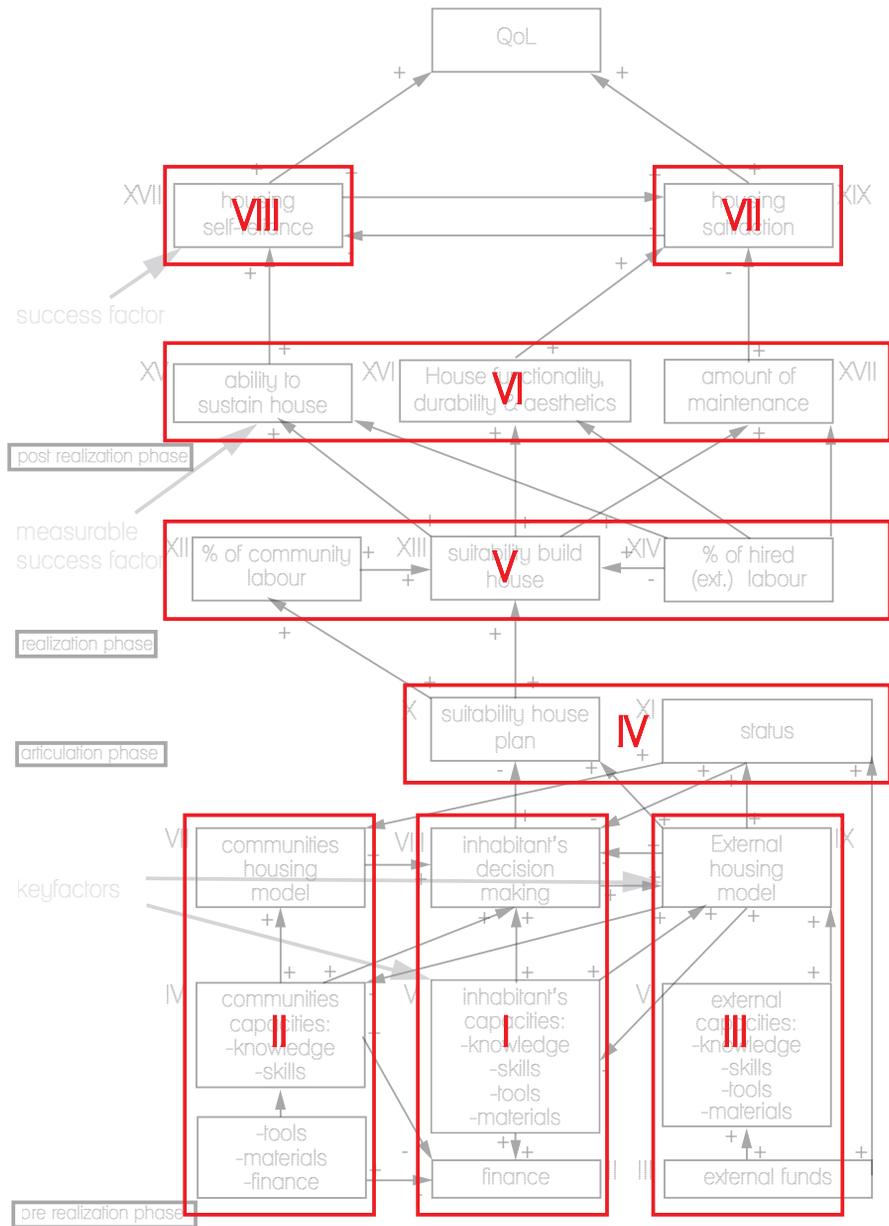


FIG. 6.42 Combining the factors in groups and phases

Based on the excel file (Appendix O) the studio management can use the filters options in excel to see the related questions per factor.

Writing out the impact per factor is complicated, time consuming and can lack overview. For this purpose, the studio management needs to formulate a coding to clearly state on which question the finding is based. Appendix P provides with coding samples which should be used, moreover doe the appendix provides with examples how the coding should be used in writing the impact. The most important consideration for the studio management in writing the impact is the comparison of the outcomes between the support groups and the control group.

- After finishing the studio's findings the studio management can start writing the main outcomes of the studio. Here the studio management clarifies to what extend the support constituted to the level of self-reliance families experience regarding their housing (see left image, Figure 6.43). Moreover, comparing these outcomes to the level of self-reliance of the control group family has regarding their new housing (see right image, Figure 6.43).

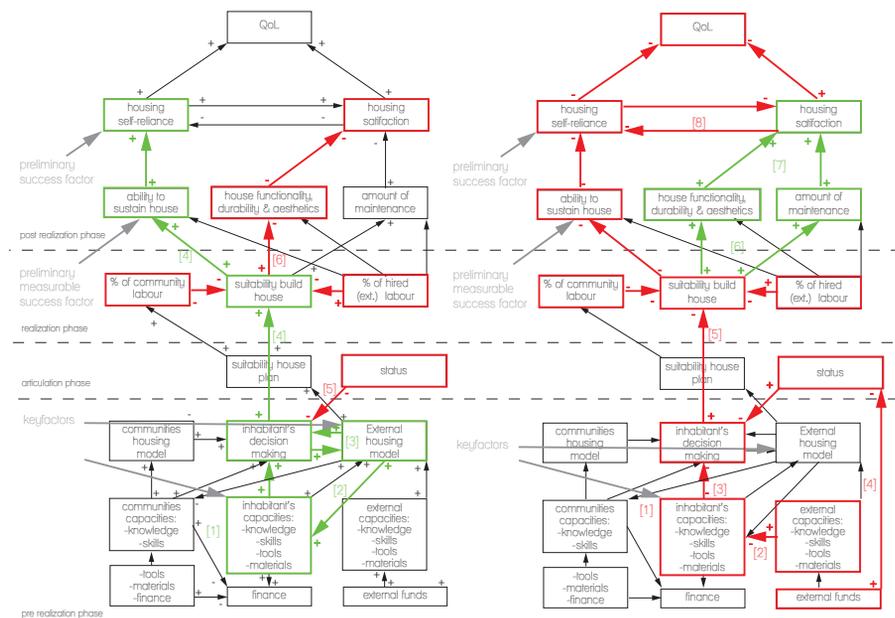


FIG. 6.43 Left: Impact Model support groups, Right Impact Model control group (author, 2019)

- 8 Running the studio, the management has made many observations throughout the process. Although these observations can't be directly addressed to the impact, they might contain important consideration for organising the studio in the future. For this purpose, the studio management is requested to list:
- fundamental problems that have to be resolved to improve the effectiveness of the studio, called barriers.
 - Important considerations that prevent the studio from getting the maximum impact, called thresholds.

Clarifying to which factors the barriers and thresholds relate, the studio management should make models as seen in the figure below.

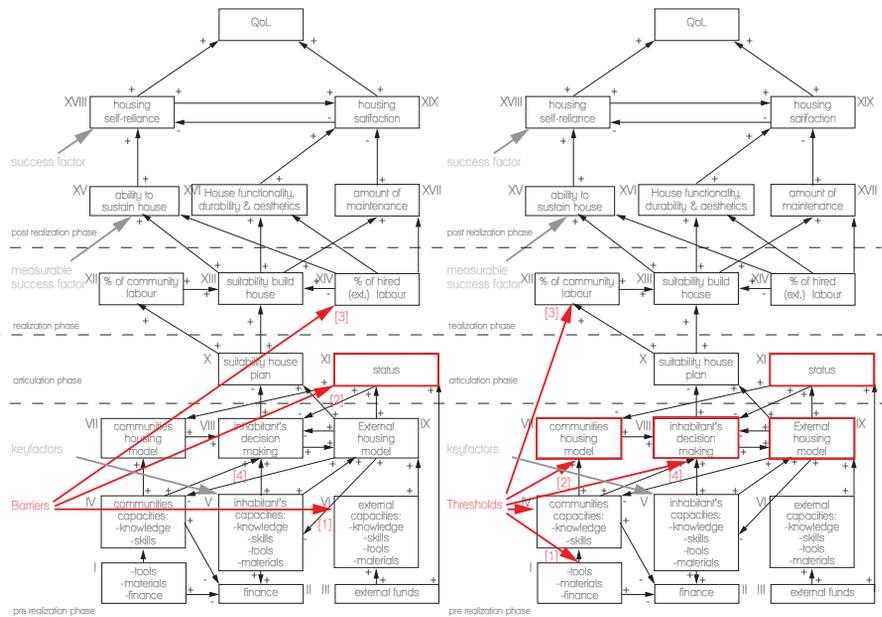


FIG. 6.44 Barriers and Thresholds in the impact model

Suitability Support Tool protocol

As elaborated in section 5.7 the suitability consists of two main elements: gathering Support Tool's feedback during the studio and evaluating the Support Tool's suitability after the teams finish.

- 1 As stated in the Support Tool protocol (section 6.6.2) the studio management is responsible to collect the feedback per chapter. This data is gathered weekly together with all the other data. The collected feedback has to be combined into one overview listing the feedback per chapter, as shown in Appendix Q. To make sure that the original feedback of the person remains identifiable, the comments need to be coded. Before the analysis and subsequent adjustments to the Support Tool can be formulated the comments have to be checked on mistakes (see Appendix R). The studio management should group the feedback per topic. After the feedback is structured, the Studio management has to react separately to every feedback point, for example:

A.AK: For the users some uncertainties remain in applying the roles (actor/observer) in the field (if it's better to swap roles during lunch or should the roles remain for the whole day).

- a *A.AK: The benefit of switching roles is that both members stay focused during the day, although the overall process might take longer.*
- b *A.AK: The benefit of not swapping roles is the clarity of the person being in charge for that day (preparations and responsibility).*
- c *S.PR: With the actor in charge all day this requires a lot of energy and focus.*

(R): Changing the roles daily would make the preparation and communication to the family clearer. However, as stated by the architect as well as the student there will be more focus and energy when the roles are divided per half day.

After listing and reacting to all the feedback per chapter the studio management can now generate an overview of all the adjustments to the Support Tool. In Appendix S the overview of the Support Tool adjustment of the pilot studio are shown. The gathered information from future pilots should be shared to the author of the Support Tool for subsequent adjustments.

- 2 To measure the suitability of the Support Tool and studio, the studio management has to setup an online survey. Appendix K provides with an example of the GoogleForm-survey used in the pilot studio. Although the first section is general and not mandatory, it is advised to use the entire survey as suggested in the appendix. After publishing the survey online and when the teams have finished all their activities, the survey can be conducted. The management provides with a room and beverages to conduct them. It is vital that the management instructs and monitors that the team members are not talking during the survey.

When all the support teams filled in the online survey the studio management can export the outcomes in excel (for example see Appendix T). Due to the length of the survey the team members might have skipped questions, contradicted themselves/ team member or have made questionable statements. The studio management therefore has to screen all the surveys individually and mark these points.

The studio management organizes in-depth follow-up interviews with the support teams to inquire on the previously identified points. First the team members are interviewed separately to clarify the identified points, when both interviews are conducted the team members join in the last feedback interview. Here the studio management clears the contradictions between the team members and finalizes the feedback. This process is repeated for all the support teams.

- 3 Combining all the feedback from the Support Tool, the survey and the interviews the studio management can compile a list of the confirmed recommendations to the tool and the studio. This list is shared with the author of the Support Tool for subsequent adjustments.

6.8 Secondary Outcomes Descriptive Study 2

The most important outcomes of this research are addressed in the answers of the identified research questions and goals. This research also develops approaches, methods and tools which are tested and evaluated in practice. These identified criteria, experiment design, or practical tools (guides, instructions, etc.) are secondary outcomes which are useful for other researchers. This section addresses these practical outcomes.

Goal A: Support Impact

The previous chapter described the design of the experiment, the necessary approvals, ethical guidelines, and the design of the impact measurement. The executed impact measurement in this section used the prescribed interview cycle through:

- Appendix H: Baseline measurement, interview guide (all groups)
- Appendix I: Impact measurement, interview guide (support groups)
- Appendix J: Impact measurement, interview guide (control group)

To compare and confirm the outcomes the questions of the interviews had to be cross-referenced with the impact model. How you can organise this process was explained in this chapter.

- Appendix L: Overview of the cross-referenced interview question with the impact model
- Labelling questions to multiple factors
- Cross referencing questions between traditional, current and desired housing

Other useful documents in the interview process were:

- Appendix M: Example transcriptions of in-depth baseline interviews
- Appendix N: Example transcriptions of in-depth impact interviews
- Appendix O: Example observer sheets which helped to register questions during the interviews

Writing the interview outcomes in relation to their identified factors is complicated. To provide with a clear analysis a coding was setup (see: Appendix P) and used to refer to the original interview and question number. The outcomes presented in Appendix P are the fully referenced. The outcomes written in the previous chapter

Goal B: Support Suitability

Besides the support's impact this section also addressed the support's suitability to its user (practitioner).

- Appendix E: the Support Tool.
 - In the support every page has a section in which the user can address the feedback
 - At the end of each chapter there is a section where the user can reflect on the chapter's suitability.
- Appendix K: Feedback Survey support groups, how the suitability of the support can be evaluated through an online survey.
 - Questions which address user capacities prior to the quasi-experiment
 - Questions on the support's suitability during the quasi-experiment
 - Questions on how the user looks back at the suitability of the support to realize self-reliant housing
 - Questions which reflect on teamwork and its influence of the team's effectiveness
- Appendix Q: Overview of all the registered feedback by the users in the Support Tools
- Appendix R: Analysis of the feedback
 - How to treat feedback by the users
 - How to code the feedback
 - How to evaluate changes to the support.
- Appendix S: Overview of the required adjustments to the support per chapter
- Appendix T: Outcomes of the online survey (Appendix K)



7 Conclusions, reflections and recommendations

7.1 Conclusions

The outcomes of this research project show that it is possible, with the use of the design research methodology, to develop a technological design featuring a) a tool to help practitioners in articulating suitable design support and b) methods to analyse the effectiveness of the support tool. Using the developed protocols, it is possible to organise the support tool's studio, apply this tool in situ, and measure its impact and suitability. The use of these protocols shows that the support tool enables practitioners to analyse and integrate inhabitant capacities into the design process of suitable rural housing solutions that sustain or improve the family's self-reliance regarding their housing.

The motivation for this technological design was twofold. Firstly, Mt. Elgon inhabitants are confronted with a disparity between their existing capacities and those required for their desired housing. As a result, most families in the region are not able to improve their housing. Secondly, external practitioners lack the training and tools to articulate improved housing solutions that would meet the inhabitants' capacities. The following sections link this project's aims to its conclusions.

The first aim was to investigate how inhabitant capacities can be evaluated by practitioners in situ. The testing of the Rural Housing Studio, and more specifically the use of the Rural Housing Support Tool, shows that the capacities of involved families were insufficient to realize their desired housing; these families required the assistance of practitioners to formulate alternative suitable housing. Moreover,

practitioners who lacked the tools (see control group) to evaluate inhabitant capacities did not or could not integrate those capacities into housing solutions. Like other families in the community who realized their desired housing, the control group was unable to maintain, extend or replicate their house without external support. The research outcomes prove that the support group families, in contrast to the control group, used alternative housing solutions mainly based on existing capacities.

The second aim was for the involved practitioners to identify family capacities and integrate them into suitable housing design by using the format of the Rural Housing Studio and subsequent support tool. This aim was realized, as the practitioners were able to gather available inhabitant capacities and integrate them—with the help of the families—into suitable improved housing.

The third aim was to test whether the application of the technological design sustained or improved the family's level of self-reliance regarding their new housing. All groups using the support indicated that they had the financial means to finish the house and would be able to maintain it even if their income diminished, whereas the control group could not make these guarantees. In new housing, the control group mainly depended on the funds provided by their team and a loan; moreover, they required additional funds to finish or to maintain their new housing. This confirmed that the support stimulated the practitioners to articulate housing solutions within their family's current financial capacities.

The control group used only manufactured, non-local materials, while the support groups used natural materials to various degrees. Consequently, most of the teams did work with non-local, manufactured materials. Two support groups mainly utilized local materials due to the high financial constraints or due to a strong ethical motivation. This confirmed that the support stimulated the practitioners to articulate housing solutions that incorporated locally available capacities and resources. Which prompted support group families to use local materials within their current capacities.

The support group families needed the team's knowledge to articulate alternative building materials and components. One family member was present each day to participate in the building activities. The control group family only needed the team's knowledge to produce a design, and the family did not participate in building activities. The control group family did not think they were trained to build the house by themselves, concluding that they would depend on hired labour to finish and maintain the house.

Most of the support group families could not have built improved housing given their existing capacities. The control group only needed the team for a design and for funding. This demonstrates that the families required external help to realise improved housing within their existing capacities. The studio and subsequent support helped to bring practitioners to families that required their help in realizing improved housing.

As housing plans were not made in traditional housing planning, it was difficult to describe their improvement in relation to desired and new housing. Traditional housing was flexible and adjusted to a complex set of variables: available resources, climate, time of year, size of the family, etc. In desired housing, this flexibility was lost due to the financial constraints, resulting in a disparity between the amount of living space the family needed versus the desired quality of this space. In the experiment, all the teams were able to articulate a housing plan that suited the requirements of the family. Although the impact of the support on the housing plan was not significant, the support did stimulate the practitioners to articulate housing solutions that suited their family's preferences and fit their capacities.

All the support group families thought they had the knowledge, skills and means to finish their house, whereas the control group did not. The support group families could make repairs by themselves and were able to afford them. More importantly, they could extend and replicate the house by themselves. The control group thought they could perform repairs by themselves; however, they were not able to extend or replicate the house. The support therefore stimulated the practitioners to share their knowledge and training within their family, enabling the support group families to maintain, extend or replicate the solutions their teams offered. Resulting in a comparable and, in some cases, even improved level of skill and knowledge in comparison to previous and desired housing.

In the new housing, the teams using the support analysed and integrated their family's capacities into housing solutions, enabling their families to finish and make repairs to the new house themselves. The families had or could afford the required materials even with a reduction in income, and they believed they could extend or replicate the house by themselves, supported by their community. The control group stated that they would be able to maintain the house, even if their income diminished. However, they were unable to afford the necessary materials and labour to do so; moreover, they could not extend or replicate the house by themselves. The families could not have realized improved housing without the help of the team, although the kind of help they received differed drastically between the control group (financial support and design) and the support groups (new brick and foundation technologies, learning to measure, etc.). This reveals that the studio and support

stimulated the practitioners to analyse the families' existing capacities and integrate these into an alternative housing solution. Thus, the practitioners were able to share their knowledge and train the family to build new housing by themselves, improving their ability to maintain, extend or replicate the house even with less income. Therefore, the support group families experienced a high level of self-reliance regarding their new housing.

The fourth aim was to test whether the support tool was suitable for the practitioners in realizing self-reliant housing for rural inhabitants on Mt. Elgon. In the period prior to the project, participants would have used a short and traditional process: interviewing their clients, developing the design brief and proposals, producing technical drawings and managing the building phase. Their task would have been to offer design and technical solutions. This role would have been rather formal and focussed on understanding the family's wishes and demands, translating these into a design and managing the family's expectations throughout the building phase. In other words, the practitioners would follow a normative professional role that would mainly focus on spatial necessities and financial capacities.

In contrast, the support tool guided the practitioners to a different role where the client (family) participated in the entire process. Families could thus understand why certain decisions were made by the practitioners and could learn to make these by themselves in the future. Furthermore, the support tool provided methods that enabled the practitioners to make observations and inquiries, giving them a more detailed understanding of the family's daily spatial requirements and problems. This resulted in a more suitable design brief and house design.

The majority of the practitioners found the support tool useful in formulating a self-reliant housing solution for their family. Moreover, the support did not force a specific technical solution, allowing the practitioners to articulate their own. The studio management remained impartial and did not tutor the teams during the experiment. All support teams executed the support tool according to the protocol. The studio and support tool did not force a specific technical solution, and practitioners were able to work independently from the studio management. Thus, it is clear that the support tool was executed with as little interference as possible and that the outcomes are suitable for impact measurement.

The practitioners found chapters 1, 2, 3, 7 and 10 of the support tool useful to better understand the context. Chapters 3, 4 and 8 helped them to involve family through the entire design process. Practitioners found chapter 11 the most fundamental in enabling them to train their family to maintain, extend or replicate the house by themselves; therefore, they considered this chapter to be the most important for

increasing the self-reliance of their families regarding their housing. This confirms that the support tool was well suited to observing, interviewing, mapping and analysing in order to better understand the context in which practitioners' families lived. The support helped the practitioners to make the family part of the design process and kept the team in charge of making the decisions about their new housing. Most importantly, the support helped the practitioners to share knowledge and train their family while constructing the new house. It provided the practitioners with suitable support to increase inhabitants' level of self-reliance regarding their new housing.

7.2 Reflection

The reflection consists of two parts. Part one considers the **impact** of the studio's and support tool's key components in articulating self-reliant housing. Part two assesses the **suitability** of these components **for practitioners** to articulate self-reliant housing.

7.2.1 Reflection on the research outcomes

The studio had a well-defined selection procedure that offered a clear overview of the current capacities of the families. Families with similarly low financial capacities were chosen, as this provided the mediation between help needed by the families and measurability required for the studio's impact. However, two families gave misleading information about their income and savings during the baseline interview. Consequently, it was not until the construction phase that the teams found out that their family had much higher financial capacities. This was also confirmed in the impact interview, where the families stated that they had sufficient funds (the other families did not) to realize their desired house, making their participation questionable. Both these families constantly challenged the team's building solutions and caused many problems during the construction of the new house. For instance, one father tried multiple times to force the use of his desired materials (destroying parts of the house during the weekend and rebuilding it with new materials), although at the end of the project he did not have the funds to finish the house. The other family dropped out after refusing the use of compressed earth bricks in the

new house. All families participating in the studio were aware that manufactured materials were more expensive, and despite not having the funds, they still preferred them for their housing.

The control group family could not have realized the new housing based on their financial capacities and access to loans. Offering monetary assistance to this family resulted in low participation during the construction of the house and even caused undesirable behaviour that their team considered undesirable. However, the family found the attention positive, boasting that they had foreigners financing and constructing their house for them. The support group families did not receive any loans from their teams and depended largely on their savings. A year after experiment's completion, none of the families were able to finish their house due to the lack of available funds, putting enormous stress on them. This indicates that a low level of income and funds has a tremendously negative influence on the effectiveness of the studio in offering alternative housing solutions. Moreover, having no finished housing after completing the studio threatens the livelihoods of the families. Although the studio did not want to set a bad example by finishing the houses for the families, help should be offered if the houses are still not finished once the studio is completed. Key component 9 of the support helped practitioners to let the families fully participate throughout the entire process; however, it did not wholly succeed in helping practitioners to convince their families to accept the offered solution given their financial capacities.

Outcomes of the baseline interviews show that families used fewer natural materials in their former housing than was found in the household survey. In spite of stating that they would consider cheaper alternative materials, the experiment showed that the majority did not want them in their new housing. This is partially due to the unknown characteristics of the materials and partially because they are associated with traditional building approaches that are considered socially degrading. Despite the high costs, the families had a shared vision of desired housing that would consist solely of manufactured materials and would not be self-built. This confirms the disparity between the materials families can afford and those they desire. Key components 3, 5, 6, 7 and 8 of the support helped practitioners to thoroughly investigate the families' capacities. Key component 9, however, insufficiently helped practitioners to address the families' wishes and desires (key component 4) in the final design proposal. Subsequently, not all families were convinced by the selected (sometimes unknown) materials. The support ultimately did not allow the practitioners to experiment and convince the families of the advantages of some of these new materials, causing various uncertainties.

The inhabitants said that if they had the necessary knowledge and skills, they would prefer to build their desired house by themselves—although they later contradicted this, stating that given the option, they would prefer to hire labour to build the house for them. The families showed a very high willingness to learn to build their desired housing, although they did not seem aware that this would require them to take extensive vocational training over a long period of time. Although communally supported housing construction was an important key factor of the support, this was not practiced anymore by the community. In current housing, the families already depended on hired labour to construct some parts of the house, which resulted in their preference for manufactured materials (also expressed for their desired housing) and for more complicated construction technologies than those associated with traditional housing.

Everyday participation by the support group families was mandatory (by contract). Fathers were often not present on the construction site and the family members who were present often helped in the form of cooking lunch or providing unskilled labour. The aim of family self-reliance required more family members to participate throughout the construction of their house. But as not all family members spoke sufficient English, there was a severe language barrier that constrained the teams' ability to make joint decisions with the entire family. On only a few occasions did the community volunteer to help some of the families, thus limiting the knowledge transfer and skill training severely. The families stated that they received help from community members; however, the outcomes of the experiment showed that almost all community labour was financially compensated or simply hired. The help they did receive from the community was marginal and unskilled. Furthermore, if they received help, the families did not plan to assist the community members in return. Because families participated less than was initially assumed in the support, one might doubt the actual abilities of the support group families to maintain or replicate the offered solutions. The studio and support wrongfully assumed that both the family and the community would have sufficient time to participate in the construction activities. Moreover, the support did not allow the practitioners to convince the community to share or trade materials, tools and labour. And while key component 10 helped with planning the general construction of the house, community capacities were not offered. Key component 11 did help the practitioners to train their families on offered housing solutions, but the amount of training was limited due to the low participation of the family and their community. This drastically constrained the impact of the studio and support tool and mainly limited the improvement to the family.

In articulating alternative housing, the families relied on the external support offered through the experiment of this research. Due to the support teams' lack of

local construction experience, the families consulted local unschooled engineers (fundis). Like the families, they rejected the unfamiliar solutions offered by the teams and played a vital role in the families' decision-making process. Though only one team made small mock-ups to show the effectiveness of their solutions, even this was insufficient to convince the family. It seems that there was a fundamental flaw in the design of the studio, the composition of the team and the effectiveness of the support (further addressed in the recommendations section below). Similarly, key component 9 did not allow the practitioners to convince the family of their articulated solutions.

Status was undoubtedly the most important unforeseen factor of this research project. The house is a large contributor to the social position a family holds in their community. Thus, even when the family does not have the financial means to hire labour in realizing desired housing, they do prefer it given the option. Although this was not clearly proven in the interviews, it seems that the families take pride in having a house built for them. This can have far-reaching consequences, as discovered with the control group, where the family found themselves part of a higher social class in their community after getting a permanent (desired) house. Therefore, adjustments to key components 3, 4 and 8 are required to better suit the priorities of the family.

Due to the irregular and low participation of all families in the building process, it is unlikely that they will be able to perform the repairs by themselves or extend and replicate the house. It is remarkable that some of the families stated that they do not foresee a need for maintenance activities on their new houses. This shows how little building knowledge was actually transferred between the families and their teams. And while the required capacities were considerably better aligned with those of support group families than was seen in the control group, the families will depend on financial capacities that reach far outside their current situations. Therefore, the families' high confidence in their ability to sustain their new housing is, while admirable, largely unfounded. Key component 11 did enable the practitioners to train their family to maintain the house by themselves. However, the studio's impact measurement and key component 11 require a model to evaluate the family's actual ability to sustain the house.

The level of self-reliance the families had in traditional and former housing was high. Although they often only maintained walls themselves, they had the means, resources and knowledge to repair, extend or replicate their houses, even if their income diminished. By contrast, with desired housing, the families depended on hired labour and needed to buy most of the materials. Although the families thought that these houses would require little or no maintenance, they would in

fact demand substantial financial resources. The support tool helped practitioners in various degrees to understand the importance of capacities for rural housing development (key component 1), approach the locality with caution (key component 2), understand their family's dream house (key component 4), evaluate their family's capacities (key components 3, 4, 6, 7, and 8), integrate these into design solutions (key component 9), plan the construction activities (key component 10), and train their family to maintain, extend or replicate the house by themselves (key component 11). Although the majority of the support group families were satisfied with their housing and considered the impact of the studio positive, the points addressed in this reflection do require adjustments to the studio design and support tool. Therefore, these are addressed in the recommendations section 7.3.

7.2.2 Reflection support tool suitability

The participants using the support tool found its application, and that of the current studio design, to be rigid. They felt forced to follow the support step-by-step to keep differences between the teams to a minimum (due to the experimental setting). In a more conventional project, the teams using the support tool felt they would have been allowed more flexibility in its application. The survey results also show that the support tool users felt that the amount of research time was out of balance with the realization time. Both students and practitioners would have preferred to spend less time on research and more on articulating housing solutions.

The teams using the support tool admired the focus of the studio and support on helping individual families, though this also created envy in the targeted community. As the studio and support did not directly benefit the community as a whole, community participation remained low. Moreover, rural communities are developing at such a rapid pace that community members no longer tend to volunteer in realizing each other's housing.

The support tool users felt that their relationship with the family would usually have been more formal. In a regular project the practitioners would articulate a design brief, develop designs, make technical plans and guide the construction process for the family and not with them. Key components 3, 4 and 8 helped the support tool users to get families very involved, though they also decreased the autonomy of the teams and enabled the family to force more of their preferences than would normally have been the case. The participants using the support tool felt that although this inclusive process was positive, it also partially contributed to the application of more manufactured materials than planned. The support and experiment design brought

the team and family so close that the teams struggled to remain impartial and professional in the construction process—even though this proximity to the family helped the team to design tailored housing solutions. Therefore, the support tool, team selection criteria and experiment organization demand adjustments to better match the requirements of the assignment.

Additionally, the teams using the support tool found that the support required more technical competences than would have been the case in a traditional project. Users did not always have these competences, so they sometimes found the studio's, support's and family's expectations difficult to meet. Therefore, the composition of the teams and their competences should be reconsidered to match the requirements of the studio assignment and support.

The support tool users further found that the support helped in articulating self-reliant housing solutions; however, these did not align with the existing preferences of the families. It seems that the support currently insufficiently addresses solution acceptance by the family, which explains why so few of the articulated alternative housing solutions were adopted.

Although the participants using the support tool found key component 12 useful in objectively examining the way they worked in the field, they also felt that it restricted the amount of work they could perform per day. These users often felt divided into a double role where they had extensive responsibilities both towards the research team and towards their family. They felt that swapping actor and observer roles was unnecessary and time-consuming, and as a result most teams abandoned this clear role separation.

The teams using the support tool deemed most key components useful in analysing and integrating the existing capacities of their family into housing solutions. However, the key components assume that the family and community are very willing to participate in the realization process. The support tool users felt that this willingness was actually much lower than described in the support and therefore did not suit the current socioeconomic situation of the family and community.

Key component 9 did not sufficiently allow the practitioners to introduce alternative material and construction solutions (unknown to the families), according to the support tool users. As a result, they found that the support was unable to help them convince the family to accept the articulated solutions.

Key component 11 was found useful in training the family in the offered housing solutions, but this now only applies to the realization process. The support tool users felt that this training should have started from the day they began.

Despite these many problems and potential alterations, it is important to state that there was a significant difference between the outcomes of the support groups and those of the control group. The studio and subsequent support positively contributed to the inhabitants' self-reliance regarding their housing. All the same, there are some fundamental challenges that need to be addressed before a consecutive experiment can commence. The next section, therefore, provides the main recommendations regarding the technological design.

7.3 Recommendations

The first recommendation addresses the vulnerability of the participating families. Although this research project passed all local and international ethical guidelines, it became clear in retrospect that the contracts signed with the families exposed them to unintentional dangers. Based on the family's capacities, housing was designed and realized. If the house was not completed, the family was left to finish their house without the help of their team. However, most of the families did not have the identified capacities available at the moment they needed them, leaving unfinished houses exposed to the elements. Although it was agreed upon in the contract, this resulted in some of the families having damaged houses; in fact, one new house was completely destroyed. The studio should have protected the families and guaranteed the completion of the house, even if this contradicted the main set goal (realizing housing without external financial and material support).

The second recommendation reflects on the family situation. Although all selected families stated that they could speak English, in most cases this was limited to one family member. This caused a major communication barrier between the team and their family during the research and the realization process. More importantly, it put severe constraints on the impact and outcomes of this research project. In most cases, only the fathers spoke sufficient English, and all the responses (interviews, discussions and decisions) were solely based on their point of view, which might have unintentionally reinforced patriarchal norms. With the fathers often absent during the construction process, this limited the knowledge transfer to the family. If

the support is to continue to work with non-local practitioners, the process needs to better include and validate the views of entire families.

The third recommendation concerns the contemporary socioeconomic situation of the targeted community on Mt. Elgon. The initial observations and the household survey concluded that the families mainly lived in traditional housing. Based on these findings, the support tool described a community situation that was inaccurate. While freely sharing materials, tools and labour might have been common in the traditional housing, it is rapidly disappearing within the targeted community on Mt. Elgon. Although building houses communally would help the most vulnerable families to realize improved housing, it is not applicable owing to the ongoing development towards a more individualistic society. This trend is not specific to Mt. Elgon and can be seen in many rural African communities. It is therefore recommended to adjust the support to suit this socioeconomic situation.

The fourth recommendation addresses the role of the local builder. As explained earlier, the local builders (fundis) were a major obstacle in the experiment. They challenged the local experience of the support teams and the building solutions they proposed. However, this does not have to be the case. Incorporating the local builders into the studio, allowing them to participate in the design and realization process, would substantially increase the effectiveness of the support. It is recommended to involve a local builder in the entire process; this will help to filter out misconceptions of the teams, but more importantly will convince the local builders and families to accept the introduced solutions. The support might even be adjusted to train the local builders, as they are a key factor in realizing affordable housing for the target group.

The fifth recommendation addresses the composition of the support team. Due to the financial constraints of the research project, only four teams were deployed in the field experiment, consisting of students (who covered the expenses themselves) and practitioners (whose expenses were covered). Due to the varying ages and experience levels of the students, they were not allowed to work without the supervision of a practitioner and were therefore crucial in the chosen team composition. However, according to the support tool, the students were essential in executing the experiment. Without them, there would have been less useable feedback and data. Although this was not intended, it is therefore recommended to keep this team composition in the studio setup.

The sixth recommendation concerns the support adjustments required for future application. As explained in the methodology section of this research project, the outcomes contributed to the testing and evaluation of a first-concept version of the

studio and the support tool. To execute the studio again, elaborate alterations have to be made to both. These alterations must include the following:

- the adjusting of the protocols to maximize the impact of the team and support tool, based on: outcomes of goal A (section 6.1), barriers & thresholds (section 6.3), conclusions (section 7.1), reflection (section 7.2) and recommendations (section 7.3)
- the adjusting of the team composition to meet the competences necessary to effectively execute the support in a building practice unknown to foreign practitioners based on the user observations addressed in the: conclusions (section 7.1), reflection (section 7.2) and recommendations (section 7.3)
- the adjusting of the support tool based on: outcomes of goal A (section 6.1), goal B (section 6.2), conclusions (section 7.1), reflection (section 7.2) and recommendations (section 7.3)

The seventh recommendation regards the Rural Housing Studio. The studio's step-by-step support tool advises practitioners to analyse and integrate inhabitant capacities in order to sustain inhabitants' level of self-reliance regarding their housing. Although the studio and support were tested only on Mt. Elgon, this locality was chosen because its characteristics are more broadly representative of rural communities in Sub-Saharan Africa. Therefore, the Rural Housing Studio should be seriously considered for implementation by practitioners who realize rural housing in Sub-Saharan Africa. Because they are relevant to many other rural communities in developing countries around the world, the developed studio and support show great application potential. The analysis and integration of inhabitant capacities by practitioners could also benefit developed countries. In the past decades, European inhabitants have increasingly realized housing projects partially or completely by themselves (Ibelton, 2016; Lloyd, Peel, & Janssen-Jansen, 2015; Scheller & Thörn, 2018; Turok, 1993). The Rural Housing Support Tool provides step-by-step methods for practitioners to let clients participate throughout the entire process, and more importantly to provide training and knowledge with which clients can realize their own project. Moreover, practitioners can articulate building solutions based on what their clients already have instead of solely using capacities that they do not have.

Appendices

The following attachments are available via:

<https://research.tudelft.nl/en/persons/mwm-smits>

- Appendix A Survey Inhabitant dwelling capacity evaluation on Mount Elgon 2017 questionnaire instruction (Smits, 2017a)
- Appendix B Survey Inhabitant dwelling capacity evaluation on Mount Elgon 2017 questionnaire guide (Smits, 2017a)
- Appendix C Questionnaire Swahili, Google Forms (Smits, 2017a)
- Appendix D Dataset, Mt Elgon Survey_2017 (Smits, 2017a)
- Appendix E Rural Housing Support Tool & USB-Stick
- Appendix F Rural Housing Project Consent Form
- Appendix G Rural Housing Audio-Visual Consent Form
- Appendix H Baseline-Interview Questionnaire Guide
- Appendix I Impact-Interview Questionnaire Guide (Smits, 2017b)
- Appendix J Impact Interview Guide, Control group (Smits, 2017b)
- Appendix K The Rural Housing Studio Participant Evaluation
- Appendix L Overview interview questions per factor (Smits, 2018b)
- Appendix M Transcriptions Baseline Interview
- Appendix N Transcriptions Impact Interview
- Appendix O Observer sheets (O1, O2 & O3)
- Appendix P Goal A with coding
- Appendix Q Summary Feedback, The Rural Housing Support Tool (Smits, 2018c)
- Appendix R Feedback Analysis, The Rural Housing Support Tool (Smits, 2018a)
- Appendix S Support Tool feedback outcomes
- Appendix T Impact Survey Participant Experiment (Smits, 2018d)

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Curriculum Vitae

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Researchgate	https://www.researchgate.net/profile/Michiel_Smits2
Linkedin	https://www.linkedin.com/in/mwmsmits/

Education

02/2014 - current	PhD in Architecture, Delft University of technology (promotor: Prof. dr. ir. T. Avermaete & Co-promotor: Dr. ir. E. Quanjel)
02/2009 - 07/2011	Master Architecture, Delft University of technology
09/2006 - 02/2009	Bachelor Architecture, Avans University of Applied Science, Tilburg
09/2004 -09/2006	Bachelor Interior Design, AKV St. Joost, Breda
09/2000 - 09/2004	Technical school for Building Engineering, Baronie College, Breda
09/1996 - 09/2000	Secondary education, Nassau Scholengemeenschap, Breda

Personal Profile

Passionate to help engineers and designers to stimulate inhabitant participatory processes.

Work Experience

- 02-2019** Chairman of the 2nd & 3rd year curriculum, Building Engineering, Avans University of Applied Science
- 08/2017 – Current** *Initiator, leading researcher & project manager; The Rural Housing Studio (Kenya)*
To test the methods developed within my PhD research I established the Rural Housing Studio. Here 4 BSc. Students are teaming up with four international architects to design and build a new dwelling for four rural families on Mt. Elgon Kenya.
- 04/2016 – Current** *PhD council representative (Delft)*
As council representative for the Architecture chair, I organise events (colloquia, conferences, etc.) and guide visiting PhD's and professors.
- 09/2013 – Current** *PhD Researcher and tutor Technical University (Delft)*
Research: The aiding Architect, the role of the architect: developing design support for the architect to increase the self-reliance of sub-Saharan rural communities.
Research Mentor: Explore Lab, graduation studio MSc 3+4
- 01/2013 – Current** Independent researcher Kenniskring Innovatie Bouwproces & Techniek, Avans University of Applied Science
- 10/2011 – Current** *Owner and Architect MWM Architecture (Breda)*
- 10/2011 – Current** *Teacher & Researcher at Architecture, Avans University of Applied Science (Tilburg)*
- 08/2011 – 10/2011** *Junior Designer architecture firm Baudoin van Alphen (Breda)*
- 02/2010 – 07/2010** *Tutor at Architecture and Urban Design Msc 1-2, Technical University of Krakow, Poland*

Journal Publications

Smits, M. (2019), Towards self-reliant development_Capacity gap within the built environment of Mt. Elgon rural inhabitants, *Smart and Sustainable Built Environment Journal*

Smits, M. (2018), A quasi-experimental method for testing rural design support within a DRM framework, *Smart and Sustainable Built Environment Journal*, <https://doi.org/10.1108/SASBE-11-2017-0067>

Smits, M. (2017), Formulating A Capability Approach Based Model To Sustain Rural Sub-saharan African Inhabitant's Self-reliance Towards Their Built Environment. *International Journal of Sustainable Development and Planning*, 12(2), 238–251. <http://doi.org/10.2495/SDP-V12-N2-238-251>

Smits, M. (2014). An architect's investigation into the self-reliance of a Sub-Saharan African community. In T. Jelenski et al. (E.), *Tradition and Heritage in the Contemporary Image of the City. Volume 2 Challenges and responses*. Krakow: Wydawnictwo PK.

Workshops, Events and Publications

09/2020	Projectleider ICMNA & zelfstandig onderzoek
09/2020	Projectleider MIPPO & zelfstandig onderzoek
07/2020	Onderzoeksaanvraag geschreven & honoratie subsidieaanvraag ClickNL
04/2020	Bouwstenen voor praktijkgericht onderzoek (SIA) training tot senior onderzoeker
03/2019	Co-Organiser of the African Perspectives Conference, Delft Paper: concept outcomes PhD Research
01/2019	Journal Article (under review): Towards self-reliant development: Capacity gap within the built environment of Mt. Elgon rural inhabitants
11/2019	Journal Article
12/2018	Session chair at SASBE Conference Sydney Paper/Presentation/Article
11/2018	paper: Framework for capacity based sustainable development; planning for resilient communities
03/2018	Second round of experiments: The Rural Housing Brick

02/2018	Presenter and discussant at Tilburg International Architecture Film Festival (TIAFF)
01/2018	MOOC: Rethinking the City (TUD)
01/2018	Magazine article (Architectuur NL), quasi-experiment PhD Research
09/2017	paper: Enhancing security by instating the “shared” space as a negotiator between private and public spaces
08/2017	Head Research: The Rural Housing Studio, Quasi-experiment on Mt. Elgon Kenya
05/2017	Executive Director Ecoweek 2017 The Netherlands
04/2017	Article: Global Initiative
02/2017	Initiator & Executive director Crossovers 2017
04/2016	Article + lecture: Sustainable Built Environment Conference, Utrecht, The Netherlands
09/2015	Conference: World Bamboo Conference, Dam Yang, South Korea
06/2015	Article + lecture: Future of places conference III, Stockholm, Sweden
12/2014	Article: INTBAU Krakow 2014 (3 volume book)
10/2014	Tutor + lecture: International Ecoworkshop, Prishtina Kosovo
09/2014	Lecture: Ecobouw 2014 Jaarbeurs Utrecht
09/2014	Article + lecture: Future of places conference II, Buenos Aires, Argentina
05/2014	Tutor: INTBAU Workshop
05/2014	Article + lecture: INTBAU conference
10/2013	Tutor: Ecoworkshop, Krakow Poland
09/2013	Conference: NOCMAT, Brasil
03/2013	Tutor: Workshop, Mt Elgon Kenya
04/2011	Blog and articles students & teachers Avans College, Tilburg website
04/2011	Publication project Oswiecim (Design project MSc1 TU Delft)
03/2011	Lecture at Avans College, Tilburg website
03/2011	Article teachers and students to Kenya website
12/2010	Article BN de Stem (on my graduation project and activities in Kenya) website
07/2010	Exposition and lecture Art Boom Festival Krakow
06/2010	Published article: “Responsibility and public space”. website

Towards an Architecture of Self-reliance

Developing and Testing a Support Tool for Inhabitants and Practitioners in Mt-Elgon, Kenya

Michiel Smits

This research project focuses on how decisions made by practitioners, articulating rural housing in Sub-Sahara Africa, contribute to the decreasing level of self-reliance inhabitants have regarding their housing. Multiple case studies on Mt. Elgon proved that inhabitants have a significantly higher self-reliance level, comparing traditional to modern housing. To study this phenomenon in practice and to articulate suitable design support the Design Research Methodology was chosen. The research clarification pinpointed inhabitant capacities as the key-contributor to self-reliant housing. Household survey outcomes proved that large numbers of rural inhabitant's desire housing which they have insufficient capacities for. Indicating that the inhabitants experience a disparity between existing and desired housing capacities, moreover an inability to bridge this disparity independently, and consequently require external help.

Architect seemed most appropriate to offer this help as it consist of sociocultural, engineering and design tasks. Architects are not trained in inhabitant capacity evaluation and as no suitable design tools existed, this research project developed the required design support, its application requirements and the impact measurements. These were then tested in a pilot project on Mt. Elgon. The findings were used to evaluate the support's impact and suitability. The support tool users found it suitable to assess and integrate inhabitant capacities into housing solutions. The impact shows that the support group families have sustained their family's level of self-reliance unlike the control group. The developed technological design, with modifications, could be used not only in rural Kenyan communities, but also help others around the continent.

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