Supplemental material cover page

Article title:

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Contents

1. Final version of the questions used in the scoping phase.

Scoping interview on Science Participation. Participant number:_____

Thank you for taking this interview. We are collecting information to help understand what influences people's participation in science in their leisure time. The interview will take about 10 minutes and you can decide to quit at any time during your answers and up to 4 weeks after completing this. If you find any of my questions to be unclear, please ask me to clarify.

Q1. When not at work, how often do you visit museums, science centres or exhibitions related to natural science? By natural science I mean subjects such as biology, physics, chemistry, geology etc.

- ☐ At least once a week
- ☐ At least once a month
- ☐ 3-4 times a year
- ☐ Twice in the last 12 months
- ☐ Once in the last 12 months

Q2. Have you ever participated in any natural science related activities apart from visiting a museum? If yes, please describe which ones.

_____

Q3. I would like to show you some examples of science-related activities. Can you tell me which ones of these you consider to be active participation and which ones to be passive participation? (examples labelled A-H)

Active:_____

Passive: _____

How would you define active or passive participation in natural science?

_____

Q4. Which of these have you participated in before, if any?

_____

_____

Q5. In which order chronologically did you participate in the activities above?

_____

Q6. Have you heard of the term “citizen science”?

_____

Q7. Can you name 3 things that came to mind when you heard the name for the first time?

1._____

2._____

3._____

Q8. Do you know how you can join and contribute to any science project where you would be helping to design the study, collect or analyse data? (NOT including participating in a medical study by giving blood samples, doing tests etc.)

Yes / No

If yes, can you describe how?

_____

If no, would you imagine it to be a difficult thing to find out?

_____

Q9. What do you think are the 3 most important attributes that a person must have to contribute in a natural science project in this way?

1._____

2._____

3._____

Q10. Do you know anyone (e.g. friend, family, co-worker) who contributes to a natural science project in their leisure time?

Yes / No

Examples?_____

Q11. How interested are you in taking part in a science project yourself?

Not interested Very Interested

1----------1----------1----------1----------1----------1----------1----------1----------1----------1

Q12. What would most encourage you to contribute to a natural science project?

1._____

2._____

3._____

Q13. What puts you off contributing to a natural science project?

1._____

2._____

3._____

Q14. How much do you consider yourself to be interested in natural science?

Not interested Very Interested

1----------1----------1----------1----------1----------1----------1----------1----------1----------1

Thank you very much. Lastly, for analysis reasons, can you tell me your age? _____

Education background?

- ☐ Primary education
- ☐ Secondary education
- ☐ Further education
- ☐ Higher education

What is your highest qualification related to science?

_____

Your occupation? _____

Gender: _____

Examples of activities (same for scoping and interview phase. In the version shown to participants, each item was illustrated by an image of that activity. The images are not included here for copyright reasons)

Image

A. Identifying birds, insects, animals, plants, then submitting the information to an organisation or research group.

Image

B. Plant flowers at home for insects.

Image

C. Visited the website of a conservation organisation

Image

D. Watched a nature documentary

Image

E. Carry out open-source, DIY science projects, such as involvement in DIY Biosphere

Image

F. Volunteer for an environmental project

Image

G. Plan and visit a national park/ protected area

Image

H. Remote contribution to science projects by donating computer power, e.g. through the World Community Grid

2. Final version of the question guide for the second interview phase.

Interview guide

Thank you for choosing to participate in our study. For this interview, I shall be using this interview guide as a prompting tool to raise topics. The main focus would be to have a flexible discussion to explore your opinions and thoughts. If you find any of my questions to be unclear, please ask me to clarify. You should choose freely how much personal details you would like to include in our discussion. During the interview I may be taking notes so there may be moments of silence.

Shall we start?

Q1. When not at work, how often do you visit museums, science centres or exhibitions related to natural science? By natural science I mean subjects such as biology, physics, chemistry, geology etc.

- ☐ At least once a week
- ☐ At least once a month
- ☐ 3-4 times a year
- ☐ Twice in the last 12 months
- ☐ Once in the last 12 months

Q2. Have you participated in any natural science related activities apart from visiting a museum?

Q3. I shall now read to you some examples of natural science related activities. Please tell me after each one if you think it is a form of active or passive participation in science?

Q4. How would you define active or passive participation in natural science?

Q5. Have you heard of the term “citizen science” before? What does it mean to you?

(Informs the meaning of citizen science)

Q6. In your leisure time, have you ever taken part in any natural science related citizen science projects?

Q7. If you have participated in such activities before, how did you like it?

Q8. Do you think that there is any knowledge, skill or personal characteristics needed in order to participate in citizen science? (Capability)

Q9. Can you name a few things that would make you more likeyly to take part in citizen science? (Capability/Motivation)

Q10. What kind of things would make you more interested in taking part? (Motivation)

Q11. Is there anything in your background or how you see yourself that would influence how you take part? (Social/Professional role and identity)

Q12. Do you think it would be easy or difficult for you to take part in a citizen science project? (Beliefs about capabilities)

Q13. What would be the good and bad of taking part? (Beliefs about consequences)

Q14. Do you think taking part in citizen science would be something you plan for, or spontaneous? (Goals)

Q15. Are there other things that would motivate you to take part in citizen science? (Motivation)

Q16. Was there a special event that triggered your participation the first time? (Opportunities)

Q17. Is there anything from you surrounding, either the physical or social environment, that can influence your chances of participating in citizen science? (Opportunity)

Q18. Do you know anyone who takes part in projects this way? (Social influence)

Q19. People who are important to you, how would they react if you take part in citizen science? (Social influences)

Q20. What does a project need to have/provide to get you to participate? (Physical opportunity)

Q21. How would location affect your participation in citizen science? (Physical opportunity)

Q22. Is there a time period when you would be most likely to participate in a natural science project? (Physical opportunity)

Q23. On a scale of 1 to 10, how strong is your interest in natural science?

Q24. On a scale of 1 to 10, how strong is your interest in taking part in a citizen science project?

3. Example of the data analysis process

Meaning units	TDF domain	Code	Sub-theme	Theme
Q: What do you think are the 3 most important attributes that a person must have to contribute in a natural science project in this way? A: ...competent in what they are doing, the task they are asked to do.	Cognitive and Interpersonal skills	Capable of submitting data timely and correctly	Competent in what they are asked to do	Personal characteristics and skills of significance
Q: What do you think are the 3 most important attributes that a person must have to contribute in a natural science project in this way? A: Competence for entering information on the computer etc to convey the data.				
Q: would there be anything that you consider necessary for a person to take part in a citizen science project? A: ...they fully understand what they are doing I think...We were going around the countryside basically gathering all sorts of strange data... We would run around with guided counters and things measuring ultrasonic. God knows what else. And basically if these people didn't really understand what was, the instruments were doing, they would get some very bizarre results.		Understand what needs to be done		
I am a farmer’ s daughter and I have always had an outdoor life, always been interested in nature.	Social/ Professional role and Identity	Grew up in the countryside	Family background	The impacts of family
my background, my parents were scientists, I’ m a vet, so a science background increases my interest in biological science.		Science background in the family		
It's just something that's as a family we always did when we were younger. Um, I have brothers and sisters that, a big age gap, being 19 years older... they took me to museums for a day out. So I've always gone... as I said we were in the central London it was an easy, a cheap day out to stay throughout the day. So it's just the tradition has carried on.	Social influence	Family upbringing encouraged exposure	Family upbringing	
You know I think we are quite privileged but you know you're looking at a demographic that is sort of professional middle class people with reasonable backgrounds reasonable education and you know most of our friends have at least one degree some have more. And I've got two. So, yeah, that demographic is, I don't know, It's the sort of people who join the National Trust and they are the sort of people who would respond to what, you know, what, that Springwatch asks you to do.	Environmental context and resources	Middle-class	Monetary resources	A person’ s time, living location, and money

4. Recruitment periods and outcomes for the scoping and the interview phase of the study

Scoping	Recruitment period: 28th March - 13th June, 2019
	number of persons:
Included in study:	32
Excluded from study, by reason for rejection:	
Not the age group	60
Not living in the UK	92
Not fluent in English	4
Length of interview	21
Need to care for young child	5
Too tired	1
Not interested in the topic of the study	1
Did not want to take part/no reason given	10
Total number of visitors approached	226
Interview	Recruitment period: 26th April -13th June, 2019
	number of persons:
Included in study:	15
Excluded from study, by reason for rejection:	
Not the age group	18
Not living in the UK	49
Not fluent in English	1
Length of interview	6
Need to care for young child	0
Too tired	0
Not interested in the topic of the study	0
Did not want to take part/no reason given	1
Gave written consent but did not answer when called	3
Total number of visitors approached	93

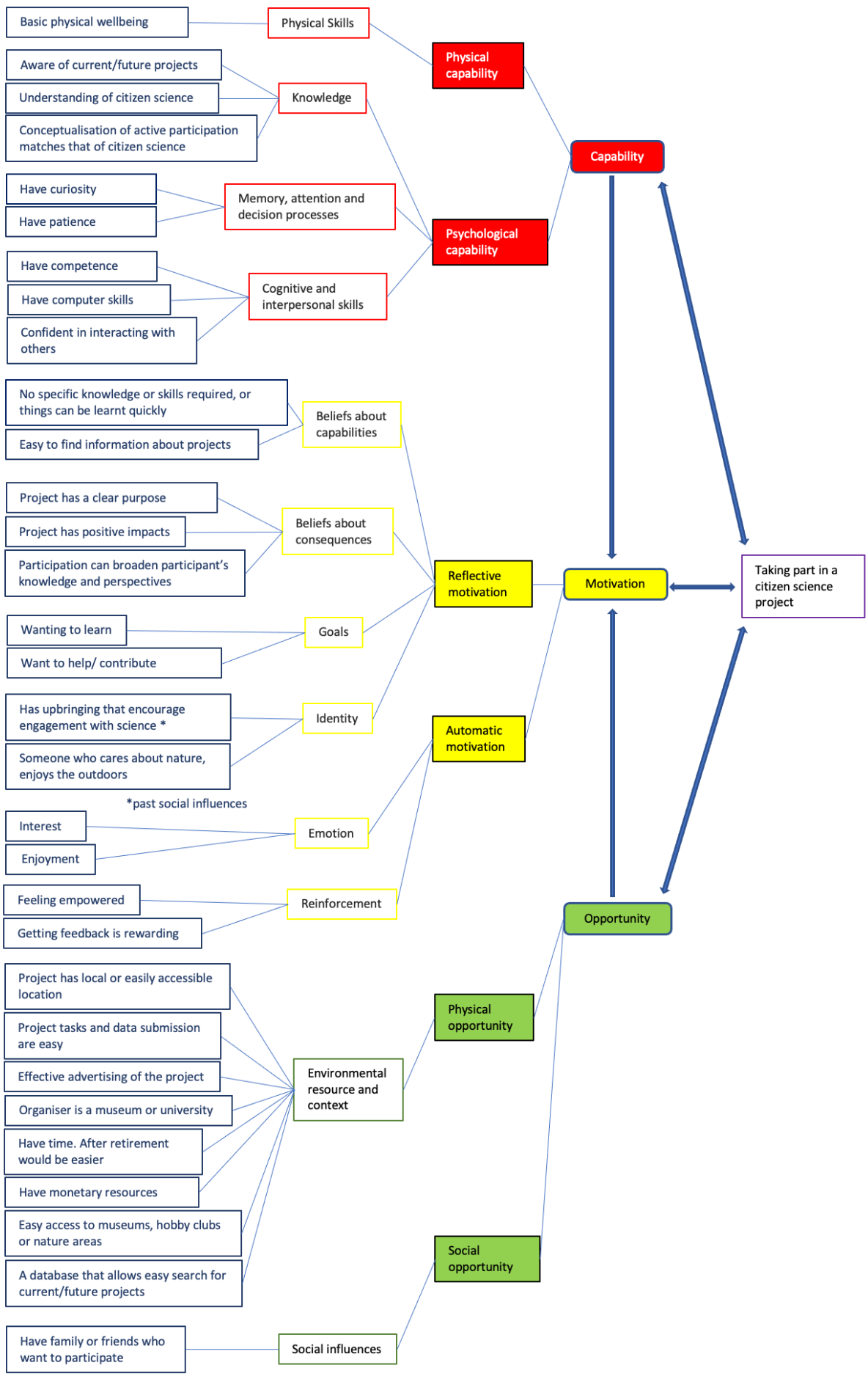
5.Participant demographics

Average interest in citizen science (min-max; number of missing answers)	How many had taken part in a citizen science project	Cultural identity	Education background	Income levels (thousand GBP per year)
Scoping				
5.6 (1-10; 0)	6	N/A	Secondary education: 1 Further education: 4 Higher education: 11	N/A
6.8 (2-10; 0)	7		Secondary education: 3 Further education: 3 Higher education: 10	
Interview				
7.4 (6-9; 2)	3	5 British, 1 British/ Pakistani, 1 European	Secondary education: 1 Further education: 1 Higher education: 5	10-19.999: 0 20-29.999: 1 30-39.999: 1 40-49.999: 1 50-59.999: 1 60 and above: 2 prefer not to say: 1
6.2 (3-10; 2)	6	5 British, 1 Welsh, 1 English, 1 Colombian	Secondary education: 2 Further education: 1 Higher education: 5	10-19.999: 1 (part-time work) 20-29.999: 2 30-39.999: 3 40-49.999: 0 50-59.999: 1 60 and above: 0 prefer not to say: 1

Demographics	Average Age (min-max)	Number of participants	Participants who had heard of the term "citizen science"	Average interest in natural science (min-max; number of missing answers)
Scoping				
Male	52.8 (42-60)	16	4	7.8 (4-10; 0)
Female	53.2 (40-59)	16	2	7.8 (4-10; 0)
Interview				
Male	52.9 (43-58)	7	3	8.2 (5-11; 1)
Female	52.5 (41-58)	8	3	7.4 (3-10; 1)

6. Logic model of how the findings influence the target behaviour

Using the TDF and COM-B, the findings are constructed into a preliminary logic model as a step in finding effective citizen science recruitment strategies. For a clearer presentation within the space available, the findings are framed as facilitators for the target behaviour instead of separated as facilitators and barriers. The subthemes constructed from transcripts are presented furthest to the left. They are grouped and matched to the relevant TDF domains then mapped to each COM-B construct. The lines illustrate the theoretical pathway by which each subtheme can encourage realisation of the target behaviour (furthest to the right).


Basic physical wellbeing
Physical Skills
Physical capability
Aware of current/future projects
Understanding of citizen science
Knowledge
Conceptualisation of active participation matches that of citizen science
Capability
Have curiosity
Have patience
Memory, attention and decision processes
Psychological capability
Have competence
Have computer skills
Cognitive and interpersonal skills
Confident in interacting with others
No specific knowledge or skills required, or things can be learnt quickly
Easy to find information about projects
Beliefs about capabilities
Project has a clear purpose
Project has positive impacts
Beliefs about consequences
Participation can broaden participant's knowledge and perspectives
Reflective motivation
Motivation
Taking part in a citizen science project
Wanting to learn
Want to help/ contribute
Goals
Has upbringing that encourage engagement with science *
Identity
Someone who cares about nature, enjoys the outdoors
Automatic motivation
*past social influences
Interest
Enjoyment
Emotion
Feeling empowered
Getting feedback is rewarding
Reinforcement
Opportunity
Project has local or easily accessible location
Project tasks and data submission are easy
Effective advertising of the project
Organiser is a museum or university
Have time. After retirement would be easier
Have monetary resources
Easy access to museums, hobby clubs or nature areas
A database that allows easy search for current/future projects
Environmental resource and context
Physical opportunity
Social opportunity
Have family or friends who want to participate
Social influences

7. Identified facilitators for participation in citizen science, and proposed interventions informed by TDF, COM-B, the behaviour change wheel, and existing literature.

Theme	Facilitating factor for participation	TDF	COM-B	Intervention function	Possible BCTs and intervention contents for recruitment (BCTs in bold)
The understanding of citizen science, conceptualisation of active versus passive participation in science	An understanding of citizen science and active participation in science that is shared by professional researchers and the	Knowledge	Psychological capability	Education	**Information about social and environmental consequences:** through traditional or digital media provide definition of citizen science and active participation in science, and inform about the benefits of participation for the individual, the science community and for solving environmental issues (Lorke et al., 2019).
Personal characteristics and skills of significance	Have curiosity in science topics; Being competent in what the project asks for	Memory, attention and decision processes Cognitive and interpersonal skills	Psychological capability	Training, Environmental restructuring, Enablement	**Demonstration of behaviour:** through media channels demonstrate participation, or demonstration by professional scientists at an individual or group level on site (West et al., 2016). **Instruction on how to perform a behaviour:** e.g. provide a step by step or interactive digital guide on how tasks should be done (Lorke et al., 2019). **Graded tasks:** set tasks with different difficulties to make participation easier for all capability levels. **Restructuring the social environment:** via school education and/or media channels to nurture curiosity for natural science.
Beliefs about one's own capability to take part	Beliefs about anyone can take part; Beliefs about it is easy to find information and take part	Beliefs about capabilities	Reflective motivation	Education, Persuasion, Modelling, Enablement	**Focus on past success:** inform about participant number in previous years, age group information and impacts achieved. **Verbal persuasion about capability:** recruitment messages that emphasise the range of contribution levels laypersons can take. **Demonstration of behaviour:** in recruitment material show individuals from varied demographics performing the tasks. **Problem solving:** recruitment messages that prompt individuals to identify barriers and suggest ways of overcoming them, e.g. information about database for current projects. Provide online resources for learning (Varner, 2014).

Theme	Facilitating factor for participation	TDF	COM-B	Intervention function	Possible BCTs and intervention contents for recruitment (BCTs in bold)
Consequences perceived as important	Beliefs about the project has a clear purpose and can make positive impacts; Wanting to learn	Beliefs about consequences, Goals	Reflective motivation	Education, Persuasion, Modelling, Incentivisation, Coercion, Enablement	**Information about social and environmental consequences:** highlight the benefits of taking part, especially contribution to science and learning, positive impact at local and larger scales (Lee et al., 2018; Varner, 2014). **Salience of consequences:** use narratives about impacts of successful project (Lorke et al., 2019). **Goal setting (outcome):** provide a list of positive outcomes of participation.
Interest, enjoyment and incentives	Interest in science, interest in the project topic; Fun activities that can be enjoyed; Project provides feedback and follow-up	Emotions Reinforcement	Automatic motivation	Persuasion, Incentivisation, Coercion, Training, Environmental restructuring, Modelling, Enablement	**Information about emotional consequences:** recruitment messages that highlight the fun element of project tasks, that taking part is enjoyable (Dickinson et al., 2012). **Feedback on outcomes of behaviour:** If data submission is digital, provide real-time interactive feedback, eg. an interactive map, or statistics about the accumulation of information etc (Varner, 2014). If task completion is physical, provide feedback through direct contact or email. **Prompts/cues:** send physical or digital posts to maintain contact after a participation, bring attention to current/future projects (Crall et al., 2017).
Impacts of family	Recognising oneself as someone who has always participated in science	Professional/ social role and identity	Reflective motivation	Education, Persuasion, Modelling	**Self-monitoring of behaviour:** create a digital diary for people to record their own science contributions. **Social comparison:** recruitment message that shows the proportion of the demographic that participate in citizen science.

Theme	Facilitating factor for participation	TDF	COM-B	Intervention function	Possible BCTs and intervention contents for recruitment (BCTs in bold)
Impacts of family	Have close family members who encourage participation; Upbringing that encourage engagement with science	Social influences	Social opportunities	Restriction, Environmental restructuring, Modelling, Enablement	**Demonstration of behaviour:** parents or other senior members of the family take part in citizen science. **Social support:** parents or other senior members of the family encourage and reinforce participation in citizen science. **Adding objects to the environment:** increase number of curriculum-based citizen science projects to foster engagement at young ages (Bonney et al., 2016).
Project details and project promotions	The spokesperson/ representative of the project is appealing	Environmental context and resources	Physical opportunities	Training, Restriction, Environmental restructuring, Enablement	**Verbal persuasion about capability:** use marketing firms and strategies such as create liking by contracting celebrities (Crall et al., 2017; Varner, 2014).
	A database that allows easy search for current/future projects				**Adding objects to the environment:** collaboration between organisations to create a database where the public can search for current/future citizen science projects according to topic, location etc. **Instruction on how to perform a behaviour:** through media spread information about such a database and how it can be used.
	Project is organised by a university/ museum; Provide clear information about tasks; Tasks and data submission are easy; Location is local or easily accessible				**Restructuring the physical environment:** if organising citizen science project as a private organisation, try liaising with a university or museum for better recruitment. Break down tasks into simple steps and use submission systems that are easy to complete (West et al., 2016). Provide a list of locations where tasks can be carried out. **Instruction on how to perform a behaviour:** provide instruction on how to access a location. Provide clear information about the time required and the tasks involved (West and Pateman, 2016).

Theme	Facilitating factor for participation	TDF	COM-B	Intervention function	Possible BCTs and intervention contents for recruitment (BCTs in bold)
A person's time, living location, and money	Have free time; Residence has easy access to museums, hobby clubs or nature areas; Have monetary resources	Environmental context and resources	Physical opportunities	Training, Restriction, Environmental restructuring, Enablement	**Restructuring the physical environment**: city planning that allows residencies to have easy access to museums or nature areas. Science establishments such as museums to encourage formation of hobby clubs as a way to promote citizen science participation. **Instruction on how to perform a behaviour**: Provide clear information about the time required and the tasks involved (West and Pateman, 2016). Inform about possibilities of flexible time commitments. Clear information about what can be done without monetary costs.

8. References

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