The Art of Behaviour

Influencing Behaviour through Architecture
How nudging can be used to positively influence user health

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ABSTRACT

As health of the population is declining and healthcare costs are rising more and more research is conducted into the influence the built environment can have on health. This research aims to improve health using a technique called nudging. Mostly used outside of the field of architecture, nudging aims to improve health by presenting options in such a way people a more likely to choose one option, without losing their freedom of choice. Within this research the question: *'How can modern architectural nudge techniques be applied to improve overall health in the built environment?'* is answered using academic literature and case studies followed by the development of a framework. First the connection between health and the built environment is established, which provides the base of the framework. Second, a list of prerequisites of ethical nudging is established, which allows architects and other non-experts within the field of nudging to set up their own ethically correct and working nudges. This knowledge, together with relevant reference projects and design elements make up the layout and content of the framework. The framework proposes design elements that influence different types of health (i.e. mental, social and physical) within different levels of society (i.e. individual, relational and communal) and can be used by architects and urban designers throughout a design phase. Lastly, the framework is reflected upon and additional recommendations for further development are made.

KEYWORDS : *Health, Architecture, Nudging, Behaviour, Guidance tool, Framework, Design Elements*

I. INTRODUCTION

The healthcare system of the Netherlands is at a turning point. Data shows that more than a quarter of the overall burden of disease in the Netherlands in 2015 is linked to behavioural risk factors – including smoking, poor diet, low physical activity, and alcohol use. Behavioural risk factors tend to be more common among people at a disadvantage because of a lesser education or lower income (OECD & European Observatory on Health Systems and Policies, 2017). Health also tends to be worse in the city, as there is a higher density of the previously mentioned groups, as well as lower mental health due to higher costs of living (CBS, 2006 & 2020).

In addition, the population is getting older. Where in 2017 one in five people will have an age above 65, this will be as much as one in four in the year 2030. This 'grey pressure' is part of the reason healthcare costs are rising steady, as well as the demand for healthcare workers.(Compendium voor de Leefomgeving, 2014; Vektis, 2018). High overall spending is mainly due to comparatively large long-term care expenditure. The system remains expensive, prompting worries over future growth and sustainability (OECD et. al., 2017). It is thus important to bring down healthcare costs.

Transition to *'healthy architecture'* however is slow. Healthy architecture is defined as: *'architecture that contributes to a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'* (Rice, 2019). Currently, the focus in the building industry mostly lays on sustainable architecture. Frameworks like *cradle to cradle, bio based economy* and *circular economy* have developed philosophies on

materiality use and production. While the field of sustainable architecture is developing an added light needs to be shed on the users of the buildings themselves. As the impact of the built environment on health is becoming more evident architects hold a responsibility to not only design healthy for the environment but also for the people. People spent twenty hours per day indoors, which makes the relation between health and the built environment worthwhile to investigate (Bos, 2019). Healthy architecture is complex as the field is still developing. Research not only focusses on mitigating the negative effects a building can have on health, but also on actually having a positive effect with research into areas like stress reduction, climate and daylight.

However, health can not only be influenced by the environment, but also by behaviour. Several studies show that architecture can influence behaviour, and behaviour can influence health. This means that the concept of a healthy building can be taken to the next level. This research aims to provide insight in how architecture can influence behaviour that positively affects health. Finally, a guidance tool will be proposed to inspire architects to design healthy buildings.

1.1. Definitions

1.1.1. Health

Health used to be defined by the WHO as the absence of disease or infirmity but that definition now changed to complete mental, physical and social well-being (World Health Organisation, 2022). *Mental health* is a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community (WHO, 2018). *Social health* of individuals refers to "that dimension of an individual's well-being that concerns how he gets along with other people, how other people react to him, and how he interacts with social institutions and societal mores" (Tognett, 2014). *Physical health* is the state of being free from illness or injury. It can cover a wide range of areas including healthy diet, healthy weight, dental health, personal hygiene and sleep. Physical health is vital for overall well-being (NHS, 2022). These three categories of mental, physical and social well-being are strongly related to each other. For example, people with poor mental health have a high risk factor for chronic physical conditions (Canadian Mental Health Association, 2022), and people who feel more connected to others, i.e. social health, have lower levels of anxiety and depression (Seppala, 2017). This shows that mental, social and physical health are not three separate components, but often intertwine and overlap.

Health can be influenced in two directions. It can be promoted by encouraging healthy activities like physical exercise, healthy nutrition and sleep, but it can also be degraded by engaging in unhealthy activities, such as smoking, stress or solitude (Centers for Disease Control and Prevention, 2021). Health is thus not only influenced by genetics, but also by environment and behaviour.

Non-communicable diseases are also called lifestyle diseases, as they are medical conditions that are not caused by infection or transmission. Most common non-communicable diseases are health problems like cardiovascular diseases, cancer, respiratory diseases and diabetes (PAHO, 2022). These non-communicable diseases account for 71% of deaths globally (WHO, 2022). There is a mismatch in ill-health causes and funding to cure this. Currently almost all effort and health funding goes towards 'absence of disease or infirmity', such as hospitals and clinics. Only 3% of healthcare spending goes towards complete mental, physical and social health, i.e. prevention (Institute of Medicine, 2010). Contemporary healthcare thus deals with illnesses once they occur rather than actively preventing them (Rice, 2019).

1.1.2. Healthy architecture

Similarly to healthcare spending the current focus within architecture lies with 'absence of disease or infirmity'. Designs attempt to not harm users, by providing safe structures and clean sanitation. Studies show that architecture and the built environment is strongly linked to health. Different architectural aspects can influence health, such as lighting and air quality (Connellan, Gaardboe, Riggs, Due, Reinschmidt, & Mustillo, 2013). Healthy architecture aims to not only mitigate the negative effect a building can have on users, but actually have a positive impact on health. This can be done by promotion of physical activity, or attempting to lower stress with materiality and nature (Heidari, Younger, Chandler, Gooch & Schramm, 2016).

1.1.3. Nudging

Common non-communicable diseases show that health is not only influenced by genetics, but also by behaviour. Recently, nudging is becoming a more widely used tactic to influence this unhealthy behaviour of the public. The term was coined by economist Richard Thaler and legal scholar Cass Sunstein in their book 'Nudge', who defined it as: '... *any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives*' (Thaler & Sunstein, 2008).

Nudging builds on the notion of libertarian paternalism according to Sunstein and Thaler. This means it preserves the freedom of choice; liberal, but encourages people in a direction that can promote their own welfare; paternal. They state: 'healthy food placement counts as nudging, banning junk food does not'. This means the freedom of choice will be preserved at all times.

Nudging means presenting choices to decision makers in a different way. A person responsible for organizing these choices is called a choice architect. Nudging started in the private sector, as a way to make of safe money. This is widely used by grocery stores. Shopping carts are large to let people buy more products, healthy products are spread throughout the store to let you also pass all the unhealthy stuff, vegetables are displayed at the start because you're more likely to buy chips after you bought broccoli and the checkout is still surrounded by chocolate bars (Hollander, 2019). Food placement in stores can influence it's consume with 25%, which is valuable information for a company (Thaler & Sunstein, 2008). After this, financial nudging techniques were quickly picked up by several government agencies to not only benefit companies but also the public. For example, the KiwiSaver in New Zealand made participation in the pension scheme the standard option when you sign a new contract which increased participation greatly and improved their economic perspectives (Thaler & Sunstein, 2008).

So nudging can be used to influence finances, but it can also be a tool to influence health. The Dutch government used nudging by making 'no objection to organ donation' the default option for people who hadn't made a choice yet in 2020. Within a year there were more than a million more people in the donor register (Centraal Bureau voor de Statistiek, 2021). Nudging was also used by the government during the Covid pandemic. Social distancing commercials, vaccination promotion and stickers promoting mouth masks are all forms of nudging.

1.1.4. Social Ecological Model

A model has been established by the WHO to better understand how social ecological factors affect health (Krug, Mercy, Dahlberg & Zwi, 2002). It comprises of four levels. Individual health includes ones biology and personal characteristics such as age, race and education. The second level includes ones closest social circle, like a partner, family and friends. The third level concerns social relationships such as school, work and neighbours. The fourth and last level, societal health, looks at health impact factors on a large scale, such as economic, cultural and social norms as well as inequality between population groups. The model originated from the field of violence and health, but has since been adopted by several health organisations to inform health promotion programs and promote overall health (ATSDR, 2015).
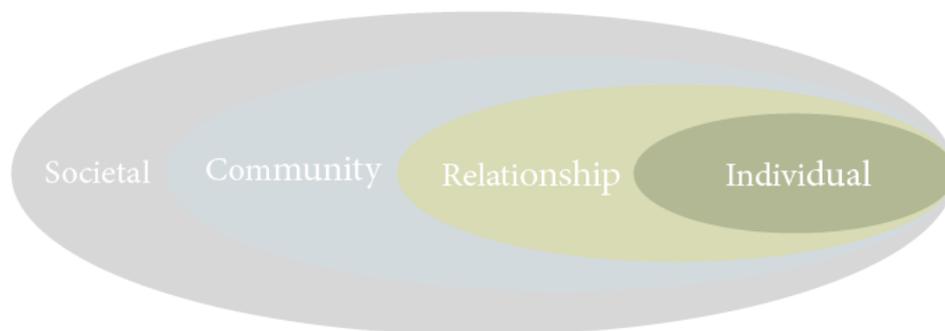

Figure 1. A four-level model of the factors affecting health that is grounded in social ecological theory, adapted from Krug et. al., 2002. (Own image, 2022).

This model allows for community engaged organizations, such as government organisations and city planners to identify a set of factors that contribute to poor health. By identifying this a broad approach at multiple levels can be established to reach the most effectivity (ATSDR, 2015).

1.2. Relevance of research

Contemporary architecture mitigates negative effects on health. Modern healthy architecture aims to positively influence health. Nudging can take this even further. Nudging has been proven to work within society, however this knowledge hasn't been applied within the built environment yet. Architects and planners can individually decide on design, but there are no general guidelines on influencing behaviour that has a positive impact on

health within the field of architecture. Choice architects are all around us, yet actual architects do not have the tools yet to implement this valuable knowledge within the built environment.

The proposed guidance tool in this research aims to provide a framework which architects can use to incorporate healthy behaviour in their design. This allows architects to facilitate healthy behaviour, while also enable users to increase control over their own health.

1.3. Scope of research

The beauty of choice architecture lays in the word choice. The framework in this research does not aim to propose how architects can force users into certain directions, but only to offer a set of guidelines into healthier alternatives. For example, by designing a shared bike service people are probably more likely to commute by bike, but owning a car will not be made impossible. The framework will always be about facilitation, and not forcing. Findings of this research can raise awareness on the influence architecture can have and may also open a debate on the responsibility architects have to design for a better and healthier future.

1.4. Research Question and Methods

This research aims to answer the question: '*How can modern architectural nudge techniques be applied to improve overall health in the built environment?*'. Its final aim is to provide a framework with guidelines and design elements that can positively influence health which architects can implement in their design. This is done in several steps:

1. *In what ways can the built environment influence behaviour to affect health?*
2. *What preconditions are there to conduct nudging tactics in an ethical correct manner, and which of these tactics achieve the best results?*
3. *What type of framework lowers the threshold for architects to implement design elements within their designs that influence behaviour that positively affect health?*

The first step to answer question 1 is to established that the built environment can affect health both negatively and positively. This will be done by analysing academic literature researching first the sick building syndrome as this is a term used to describe the collection of negative impacts a building can have on health, followed by academic literature research into the blue zone which, through empirical evidence, describes the positive effects the built environment can have on health. For the second part of the question (linking the built environment to behaviour) health is linked to current design trends that influence behaviour that positively impact each health type; mental, physical and social. The design trends are (1) biophilic design for mental health using academic literature and research into commercial quantification methods, (2) active design guideline using a case study by analysing effectiveness of New York government policy and lastly (3) co-operative design for social health using academic literature. By determining the influence of the built environment on behaviour, the relevance of aiming to change behaviour through the built environment is justified.

Question two will focus on existing knowledge of nudging. First a set of basic principles by Thaler & Sunstein will be described as they are considered as the founders of the term. This will be followed by ways a nudge can be conducted in a correct manner, i.e. when the ethics of nudging, the social construct and prerequisites are all taken into account. The second paragraph of this analysis will focus on different nudging techniques. Here a framework of nudging will be explained that is supported by several academic studies from different fields, which builds on knowledge from Thaler & Sunstein. As each technique influence behaviour in a different way a detailed description is given on how to conduct them in a correct manner as described in the first paragraph. The overall aim is to determine a set of preconditions in what ways a nudge can be conducted in an ethically correct manner (libertarian paternalism), and which of those tactics work best. With this information one could set up their own ethically correct and working nudges.

The final layout of the framework will be mainly dictated by findings from chapter 2 and literature studies on a usable guidance tool. A database of existing design elements will provide the content of the framework. These design elements are found in literature studies, existing case studies, findings from existing design trends described in chapter 2 and from existing nudging techniques outside of architecture described in chapter 3. The final goal is to set up a framework by which architects can be stimulated to implement nudging techniques that improve health.

II. HEALTH AND BUILT ENVIRONMENT

2.1. Influence of the Built Environment on health

This paragraph shows findings from influence of built environment on behaviour that affects health. The goal is to prove by examples that the built environment can both negatively as well as positively impact health

2.1.1 Sick Building Syndrome

Sick building syndrome is when occupants of a building experience acute health related effects that are linked directly to the time spent in a building. There are many causes to these complaints. Chemical contaminants like vents and building exhausts or volatile organic compounds (VOC) from carpeting, machines or pesticides, biological contaminants like bacteria, pollen or fungus, inadequate ventilation, radiation and inadequate lighting (Joshi, 2008). This can cause headaches, dizziness, nausea, difficulty concentrating, fatigue, allergies and much more. This shows that there can be a relation between buildings and a negative health impact.

2.1.2. Blue zone theory

To find the key to long life researchers started looking at where people would become the oldest. After all, a twin study showed that longevity is only determined for about one fifth by genes (Herskind, McGue, Holm, Sørensen, Harvald, & Vaupel, 1996). Other impacting factors are environment and lifestyle (Antell & Taczanowski, 1999). Optimizing these can get most people well into their 90's.

To understand the importance of environment on health a theory has been developed about ideal environmental circumstances. The term 'blue zone' is defined as a limited region where the population shares a common lifestyle and environment and whose exceptional longevity has been accurately verified (Poulain, Herm & Pes, 2014). There are five blue zones in total; Sardinia in Italy, Okinawa in Japan, Loma Linda in California, Nicoya in Costa Rica and Ikara in Greece.

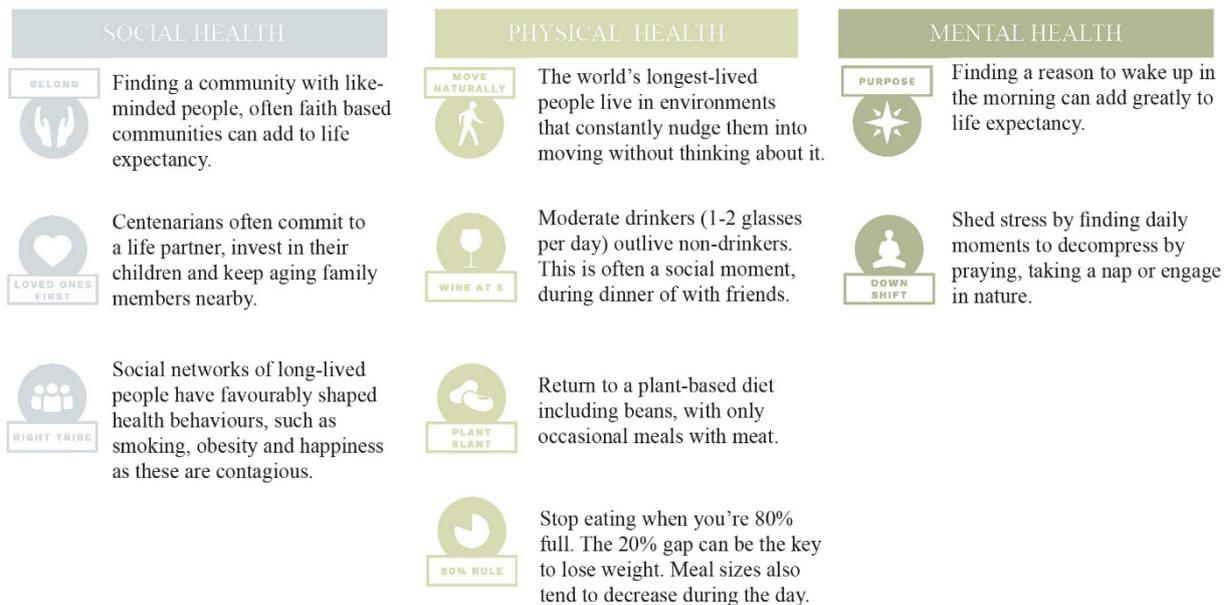| SOCIAL HEALTH		PHYSICAL HEALTH		MENTAL HEALTH	
BELONG	Finding a community with like-minded people, often faith based communities can add to life expectancy.	MOVE NATURALLY	The world's longest-lived people live in environments that constantly nudge them into moving without thinking about it.	PURPOSE	Finding a reason to wake up in the morning can add greatly to life expectancy.
LOVED ONES FIRST	Centenarians often commit to a life partner, invest in their children and keep aging family members nearby.	WINE AT 5	Moderate drinkers (1-2 glasses per day) outlive non-drinkers. This is often a social moment, during dinner of with friends.	DOWN SHIFT	Shed stress by finding daily moments to decompress by praying, taking a nap or engage in nature.
RIGHT TRIBE	Social networks of long-lived people have favourably shaped health behaviours, such as smoking, obesity and happiness as these are contagious.	PLANT SLANT	Return to a plant-based diet including beans, with only occasional meals with meat.		
		80% RULE	Stop eating when you're 80% full. The 20% gap can be the key to lose weight. Meal sizes also tend to decrease during the day.		

Figure 2. Power 9 within the three health domains. (Own image adapted from Buettner, 2021).

Between these five places there are nine evidence based common denominators, which can be transferred into guidelines to live a long and happy life (Buettner, 2021). The four categories that these power 9 originally comprise of (connect, move, eat wisely and right outlook) can be translated to the three previously defined components of health. Right outlook is mental health, connect is social health and eat wisely and move are physical health. These guidelines are about habits and behaviour, but this can be facilitated by the built environment. For example, 'move naturally' can be applied within an active design, and 'loved ones first' is the philosophy behind intergenerational housing.

2.2. Design movements

The goal of this paragraph is to provide examples on how health issues can be tackled using design. There are many examples on how to do this, but within the scope of this paper I will discuss one design movement for each health aspect: mental, social and physical.

2.2.1. Biophilic design – mental health

Biophilic design is a design philosophy that encourages the use of natural elements and processes within the built environment (Kellert & Calabrese, 2015). The term is derived from the word '*biophilia*', which explains humanity's innate affinity for the natural world (Kellert, et. al., 1993). The field is growing within the building industry, with building qualification systems such as Living Building Challenge (International Living Future Institute, 2022), Well building standard (Well, 2022) and Breaam (Breeam, 2022). The philosophy states that exposure to natural environments can positively impact health and wellbeing. This exposure can be categorized in three groups. The first is direct experience of nature, like light, water and plants. The second category is indirect experience of nature, like materials and natural geometries. For example, timber is an important feature of biophilic design, as both psychological and physical health benefits are increasingly recognized (van der Lugt, 2020). The last one is experience of space and place, like ecological and cultural connection.
There is solid socio-psychological and environmental evidence for the value of biophilic architecture as this exposure to nature can improve health and wellbeing (Newman & Söderlund, 2015). This shows that developers, designers, planners, and urban politicians can no longer neglect the value of biophilic architecture (Newman & Söderlund, 2015), and that this approach should be executed at multiple levels, from interior designers and architects, to urban designers (Heath, 2018).

As the field of biophilic design is developing there has been more research focussing on the influence of architecture on patient health in hospitals, because health can relatively be impacted the most where it is low. Brightly lit rooms can reduce length of hospital stays, and depression and anxiety rates can drop when patients are exposed to arts. (Connellan, et.al., 2013). The application of natural materials and views on nature have also shown positive effects on patient recovery times as well as pain perception (van der Lugt, 2020). But healthy architecture doesn't only positively impact patients, it can also improve safety and productivity, reduce stress and lower medical errors among staff (Voordt, 2021). Research has resulted in several changes in hospital design. For example, new hospitals have more single patient rooms to reduce spread of infection (physical health), increase dignity (mental health), and allow flexible visitation (social health) (Voordt, 2021). This shows that the awareness of the importance of mental and social health is becoming more and more apparent within different fields.

2.2.2. Active design guideline – physical health

Where in the Netherlands the health of the population is worse in the city, in the United States it is on average better. In the outer city, people drive to their destination, something that is too chaotic in a city to do. New Yorkers live 9 months longer than the average American, because they often opt for walking (Thompson, 2007). This importance of physical activity has not gone unnoticed. In 2009 the City of New York presented a set of active design guidelines containing strategies for achieving a more physically active way of life (The City of New York, 2010). Similar to the Social Ecological Model the document presents guidelines for implementation in different levels of society; universal, environmental, urban and building design. These guidelines focus on the importance of architects and city planners in battling diseases like obesity and diabetes.
Creating these healthier streets, buildings and urban spaces should invite people to incorporate healthy activity within their daily life.

2.2.3. Co-operative design – social health

Co-housing is a form of semi-communal housing consisting of a cluster of privately owned homes combined with a shared community space. The organization of the housing is run by the people themselves. This form of housing allows for people of different backgrounds to help themselves by incorporating with others, as well as strengthens the citizen by acquiring property which can generate social cohesion and harmony within a community (Prakash, 2005). This social cohesion can improve individual health by providing equal opportunity, increased social support and mutual respect, and mitigation of poverty and social exclusion (Chuang, Chuang & Yang, 2013). This example shows that individual health can be improved by designing the built environment in such a way that social construct is reinforced.

III. NUDGING

To set up a both effective and ethically correct nudge a choice architects should first understand the philosophy and prerequisites of existing techniques. That is why within this chapter the existing knowledge and nudging techniques will be discussed, which have to be taken into account when designing a new nudge. This chapter provides knowledge for someone to set up their own correct nudges. The question that will be answered here is: '*What preconditions are there to conduct nudging tactics in an ethical correct manner, and which of these tactics achieve the best results?*'.

3.1. Nudging: existing knowledge

3.1.1. Effective choice architecture

If a choice architect wants to influence choice there first must be a good understanding of how humans generally behave. For this a set of six basic principles of effective choice architecture was set up (Thaler, Sunstein & Balz, 2012). (1) The path of least resistance: People will often take the option that requires the least amount of effort. This is often the default option, or what happens if the decision maker does nothing. A way to contradict this is to require a choice, i.e. making a choice about organ donation when requesting a driver's license. (2) Expect error: A well designed system recognizes that humans make mistakes and is as forgiving as possible. For example, London streets have signs that read 'look right', as tourist do not expect traffic to approach from the right side first. (3) Give feedback: a well-designed system recognizes that humans appreciate feedback, and informs when people are doing well and when they are not. For example, flashing signs telling a driver to slow down in a curve can reduce traffic accidents. (4) Understanding mappings: a good system helps people select options that make them better off. For example, the amount of megapixels a camera can capture is meaningless to most, but mentioning that it can produce quality photos up to A1 print size is a clear reference. (5) Structure complex choices: as choices become more difficult, simplifying strategies are often implemented. For example, new movie recommendations based on old watching habits, or articles based on one's political view. This filtering can also has a downside. Good choice architects recognize that it is important for people to learn. It can thus be good to sometimes nudge people in direction that they might nog have chosen on their own, i.e. news articles or cultural events outside ones comfort zone. (6) Incentives: humans respond to reward. An architect must analyse the decision makers to give the right incentives to the right people. Examples are: showing the costs of turning the heating on, or showing the amount of calories burned on a home trainer. A good first step is to analyse the moment of choice of a nudge. To see if a nudge *in theory* would work, see appendix C.

3.1.2. Correct nudging

The core of nudging is to influence people towards some behavioural change, without taking away the freedom of choice. For it to be beneficial, it should not only follow the previously set of principles of effective choice architecture, but a nudge should also support a common good. This means it should be designed by a well-meaning party that has people's best interest in mind (Karlsen & Andersen, 2019). However, the choice architect may not always have best interest of user in mind. For example, revenue-driven mortgage brokers can have devastating effects on uninformed homebuyers. Conscientious choice architects, however, do have the capability to self-consciously construct nudges in an attempt to move people in directions that will make their lives better (Thaler, Sunstein & Balz, 2012). Choice architects have an ethical responsibility. To judge a nudgers intention Christine Clavien has set up an elaborate four level framework to assess the acceptability of nudges. These four levels are; (1) are the goals ethically justifiable?, (2) is the nudge an effective means to achieve these goals?, (3) are nudgers trustworthy?, and lastly (4) are there ethical concerns raised by the application of the nudge? (Clavien, 2018). A guide through these steps can be found in appendix D.

3.1.3. Social construct

The term Shikake originates from Japan, and translates to 'a device, mechanism, system'. It is defined as a trigger for behavioural change to solve social or personal problems. A physical trigger is used to ignite a psychological trigger, which serves as a spark for behavioural change (Yamamoto, 2015). Similarly to nudging, shikake aims to solve problems through changing behaviour, not function. The difference is that nudging works with both intrinsic and extrinsic motivators, while Shikake only works with intrinsic motivators. Extrinsic motivators are rewards such as money or points, intrinsic motivators include factors like self-confidence or belief (Matsumura, Fruchter & Leifer, 2014). This means a shikake is always a nudge, but not every nudge is a shikake. The difference thus lies in punishment or reward.

Figure 3. Tiny Shrine Gate. (Yamamoto, 2015).

The lesson we can take from this is that nudges can have limitations in relation to social construct. A symbol like the shrine only works if the meaning of a Shinto shrine is understood. This works in Japan, but would be relatively meaningless in Europe. A choice architect must thus have great understanding of the population and their triggers to design.

3.1.4. Prerequisites

Even when the previously described criteria of effective choice architecture are all met, nudges can still fail to meet expected results. Through evidence based research a list of reasons that cause nudges to fail has been set up. When an architect wants to set up a nudge these requirements have to be met as well. Reasons include timing, established habits and intrusiveness (Caraban, Gonçalves, Karapanos & Campos, 2019). A detailed description is given in appendix C.

Another reason nudges might fail is because effect are not sustained over a longer period of time. Initial results of a nudge may look promising, but often there is limited understanding of long-term effects or effects after removal (Caraban, Gonçalves, Karapanos & Campos, 2019). The fast majority of studies research the immediate effect of nudging, without taking long-term effects or backfires into account. The argument for using a nudge would strengthen if there would be more research into long term effects.

3.2. Techniques

Dual process theory states that there is a distinction between two types of thinking within the human brain, one which is automatic and intuitive, and one which is reflective and rational (Thaler & Sunstein, 2008). This is supported by the fields of modern psychology and neuroscience (Hansen & Jespersen, 2013). Automatic (type 1) thinking is characterized by fast and intuitive choices. Reflective thinking (type 2) is about deliberate and conscious decision-making, which requires self-awareness and concentration. Key features of the two processing ways are displayed in the figure. This can be established as the first dimension of nudging techniques.

Automatic thinking	Reflective thinking
• uncontrolled	• controlled
• effortless	• effortful
• associative	• deductive
• fast	• slow
• unconscious	• self-aware
• skilled	• rule following

Figure 4. Two cognitive modes of thinking, adapted from Hansen & Jespersen, 2013. (Own image, 2022).

In addition to automatic and reflective thinking there can be another dimension of nudging distinguished based on evaluating transparency. Attempting to influence ones behaviour can be objectionable as this is often invisible and difficult to measure. This allows for another distinction between transparent and non-transparent nudges. A transparent nudge is a nudge that is set up in such a way that both intention behind it as well as behavioural change pursued could reasonably be expected to the nudged individual. One could easily find the intention behind the nudge, for example the 'look right' signs in London. A non-transparent nudge is a nudge where the intention or means of behavioural change cannot be reconstructed by the nudged individual. Examples are the reduced plate size to reduce calorie intake and food waste (Hansen, 2013) or the default 'yes' to organ donation (Beraldo & Karpus, 2021). The overall question to answer to determine the transparency of a nudge is thus: 'can the user perceive the intentions and means behind a nudge?'.

These two categories classify nudges into four types of nudging. (1) automatic transparent intend to influence behaviour, (2) reflective transparent intend to prompt reflective choice, (3) reflective non-transparent attempt to manipulate choice and lastly (4) automatic non-transparent intent to manipulate behaviour (Caraban, Gonçalves, Karapanos & Campos,2019). In the image below the categories are placed in a framework, together with a nudging example.
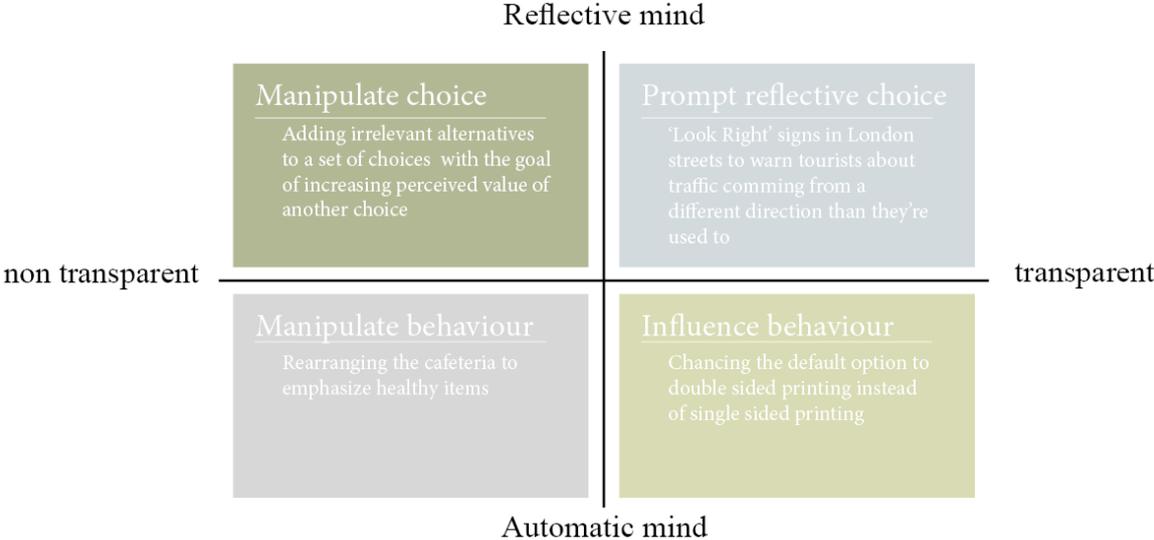
Figure 5: Four catergories of nudges with examples, adapted from Caraban, Gonçalves, Karapanos & Campos. (Own image, 2022).

A wanted result (like increased physical health) can also achieved using different tactic like manipulate behaviour (reduced plate size), prompt reflecting choice (show calories on the steps of stairs) or influence behaviour (colour code the calorie intake of food items). There is no definitive answer on which of these tactics achieve the most results, as each situation of a nudge is different. Sometimes, nudges might even work best when they are combined like the previous examples. However, there are differences between implicating them in a correct way. A choice architect must be aware of the dangers of setting up a non-transparent nudge. It is easier to set up a transparent nudge in ethical correct way because the users can perceive the intentions and means behind it. A choice architect can still opt for a non-transparent nudge, as this might be the most effective option in theory. Again, appendix D describes the criteria to establish the intentions behind a nudge, and when these are all met a non-transparent nudge can still be ethically justified.

In order for the framework to work a set of requirements was made:
- It should propose clear and readily usable design elements aimed to improve different types of health
- It should be usable for both architects and urban designers throughout a design process
- It should provide evidence of effectiveness of nudges to lower the threshold to use design elements
- As knowledge in the field is evolving, the tool should be able to evolve too

Architects should be inspired by the framework, as well as find evidence of the effect of the nudge so that argumentation of the application of the design elements becomes stronger.

4.1. Framework (development and guide)

The layout is dictated by research from chapters two. The first step for architects and urban designers who are going to use the tool is to analyse what type of health their user might need. The three categories of mental, social and physical are explained in the introduction. Why these health types might vary for different users is explained in the introduction as well, together with a guide on how to analyse this. The following option is determined by the level of implementation in society. By implementing design elements within multiple levels the most effectivity can be established. For example, if an architect wants to improve the physical health of users a design element from each level (individual, relationship, community and societal) can be implemented within a design. The last step is to make a choice between building elements and surrounding elements, which is a division of scale of the design elements. Once these three steps are done a list of design elements appears together with a source of its effectivity. These sources are added in an attempt to strengthen ones position and to lower the threshold for architects to implement the design elements. The framework can be found here: Nudging Framework. You may need to copy the link to your browser: https://tinyurl.com/yhysjapy . A complete layout of the framework can be found in appendix E.

DESIGN design elements	HEALTH TYPE			HEALTH LEVEL				SCALE		SOURCE	
check the boxes to find design elements:	mental	social	physical	individual	relational	communal	societal	building	surrounding	academic source (see tab 'sources' below)	reference project (see tab "Reference Projects"below)
fitness area	☑	☐	☑	☑	☐	☐	☐	☑	☐	The City of New York, 2010	Auburn University
shading system	☑	☐	☐	☑	☐	☐	☐	☑	☐	Cho, 2015	BE house
public art	☑	☑	☐	☐	☐	☑	☐	☐	☑	Abbott, 2013	College Square
food garden	☑	☑	☑	☐	☑	☐	☐	☐	☑	Hale, 2011	DakAkker
walking trail	☑	☐	☑	☐	☐	☐	☑	☐	☑	Schasberger, 2009	NY Highline Park
inviting staircase	☐	☐	☑	☑	☐	☐	☐	☑	☐	Boyd, 2021	IOC
drinking fountains	☐	☐	☑	☑	☐	☐	☐	☐	☑	Hickman, 2021	Paris Public Fountains
bike service	☐	☐	☑	☑	☐	☐	☐	☑	☐	Otero, 2018	Manifesto
public amenities	☐	☑	☐	☐	☐	☑	☐	☐	☑	Plane, 2013	The Goods Line
smoke free spaces	☐	☐	☑	☑	☐	☐	☐	☐	☑	Fichtenberg, 2002	Rookvrije Generatie
lighted streets	☐	☑	☑	☐	☐	☑	☐	☐	☑	Chalvin, 2017	Luminothérapie

Figure 6: The Nudging Framework containing design elements. (Own image, 2022).

4.2. Goal

The guidance tool should serve as both a toolbox and inspirational guide on how behavioural change can be applied towards healthier users. The tool can be used by architects within different stages of a design, as it proposes both architectural elements which can be implemented at the early stages of a design process, but also surrounding features or signage, which can be implemented in later stages as well.

Because the field of nudging is still evolving the tool should be able to evolve too. In the data tab design elements can be added whenever their effectiveness is proven. This allows for the database to grow, and for architects to be inspired by more design elements.

V. CONCLUSION, DISCUSSION AND RECOMMENDATION

5.1. Conclusion

The main research question : '*How can modern architectural nudge techniques be applied to improve overall health in the built environment?*' was answered within several steps.

First the relation between health and user groups, and between health and levels of society was established. The connection between the built environment and health is shown using examples that first negatively and then positively influence health, followed by the influence the built environment can have on each health type. This shows that health can be influenced in a multitude of ways. The analysis could have benefited from a comparative study showing the exact negative and positive effects, as well as the exact effects it can have on health. However, as the connection between health and the built environment is a complex theme and is worth an

entire study in itself. That is why within the scope of this study only the connection is shown to validate the development of the framework, but not the extend of it.

In an attempt to let architects and designers set up their own nudges the general concept of nudging was analysed, together with its preconditions and limitations. The provision of several steps on how to conduct nudges in an ethical correct manner work well as these allow for architects to set up their own nudges. The requirements found in academic literature are set up by specialists from the field of behavioural psychology. When an architect sets up one's own nudges he/she would have to test the nudges to the criteria themselves, but meeting the standards of ethically correct, working nudges and all prerequisites is complex.

That is why architects and urban designers can greatly benefit from the proposed framework. This framework contains design elements aiming to improve different types of health, as well as implementation within different levels of society. With this framework designers and architects can be inspired by design elements that help improve user health, as well as provide evidence for their effectiveness to lower the threshold for implementation. The different categories of nudges were defined using academic literature, and the framework was filled using academic and non-academic sources, as well as case studies. The framework is non-static, as design elements can be added to the database.

In addition, the framework can be further developed into a form where all nudges are approved by specialist from the fields of behavioural and ethical psychology. This way, an architect or urban designer can freely use the design elements with the insurance of conducting the nudges correctly without having to worry about effective and ethical concerns.

5.2. Discussion

Lastly, the guidance tool offers opportunity to architects to improve health using design. However, health is a complex subject, that comprises of much more than behaviour. In an aim to make the most impact on user health an architect should not only correctly design in relation to behaviour, but also materiality, climate, greenery and much more. Research fields like biophilic design could be implemented complementary to achieve the best result. Additionally, research within the field of nudging is young and still evolving. It is difficult to pinpoint the effectiveness of changing behaviour as nudging is not an exact science. The theory behind a nudge together with initial results can be sound, but long term research might show other findings.

5.3. Recommendations

As the tool is able to evolve there are a couple of recommendations for future developments:

- The framework should be readily accessible and growing. The final version of the tool should be formatted in a webpage
- In the future extra filters should be added, such as a selection of user types. In addition a design element should be able to be supported by multiple sources to increase validity
- The design elements within the database should in the future be approved by specialists within the field of ethical and behavioural psychology
- The tool should comprise of multiple design elements within each health type, level of society and scale so that architects can choose between a large number of elements.

VI. LITERATURE

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VII. APPENDIX

7.1. Appendix A – health and user groups

There are some remarkable health differences between population groups. People of low socioeconomic status, elderly and ethnic minorities are groups that on average struggle more with health than people with high-socioeconomic status and the ethic majority. The three types of health that account for total well-being; social, physical and mental health also strongly vary between groups. Low physical well-being is most common above people aged over 65 and lower educated. Psychological well-being is the lowest among those with the lowest income (Kooiker & Marangos, 2020). However, the three types of health: mental, social and physical strongly relate to each other. Low mental health can impact ones physical health. This shows that a population group suffering from lower health in one category, can still benefit from increased health in another category.

To find out which health aspect should be focussed on an architect must research user needs. A guide on how to approach this is given below. The steps are based on findings from architecture and product development (The University of Edinburgh, 2019).

Steps	Example
Identify your assignment	A centre for refugee's with temporary placement
Identify your users	Refugee's
Find out what you don't know	Who are they? What is their story and culture? How long will they stay at the centre? Etc…
Gather knowledge	Existing case studies Analysis Persona creation / Interviews Mapping Literature research Research into legislation Etc…
Translate to user needs: refugees need…	Calm and stress free environment Place to feel safe Place to ground Healing environment Place to connect with others
Translate to health type	A refugee centre would benefit the most from optimizing the environment in relation to mental health, with supporting social health functions

7.2. Appendix B– Would a nudge *in theory* work?

To assess if a nudge is *in theory* would work a nudge can be places in the framework shown below. These are adapted from a study providing a framework for ethical nudges (Clavien, 2018). By theory one can reason the motivation of nudges by sketching out different situations.

Nudger's point of view

Situation A

option 1
climb regular stairs

option 2
take the escalator

Situation B

option 1
climb attractive stairs

option 2
take the escalator

Ordinary stairways are replaced by attractive stairs (lights or sound) with the aim to get people ot do more physical exercise. There is still space for choice (libertarian).

Nudger's point of view

- physical effort
- small contribution to good health
- reputation of being fit
- etc..

- effort relief
- convenient
- small loss to good health
- etc...

- physical effort
- small contribution to good health
- reputation of being fit
- playing activity
- etc..

- effort relief
- convenient
- small loss to good health
- no playing activity
- etc...

- drive against physical effort
- drive for being in good health
- drive for having reputation of being fit
- etc...

- drive against physical effort
- drive for being in good health
- drive for having reputation of being fit
- drive for playing activities
- etc...

Components underlying a choice with locial motivating preferences

Nudgee's point of view in action

- I like being in good health
- I enjoy physical effort
- like that the nudger is concerned with my health
- I dislike being manipulated

Local theoretical preferences involved in a nudgee's evaluation of a choice

Nudgee's point of view

7.3. Appendix C – Ethically correct nudging

To assess if a nudge is ethically correct the following five rules have to be followed. These are adapted from a study providing a framework for ethical nudges (Clavien, 2018).

Rule	Explanation
Ethically justifiable	A nudge must be justifiable, which can be assessed by investigating the choice architects motive. If their goals are grounded on acceptable assumptions, result from good intentions and would find support among the individuals impacted a nudge is ethically justifiable.
Effective means to achieve this goal	To prove a nudge is appropriate one can look into empirical evidence (data collected according to scientific standards) showing that a nudge indeed affects people's behaviour in the desired direction.
Are nudgers thrustworthy	Trustworthiness can be established by establishing that the nudger has no conflict of interest. Secondly, a nudger can show that a nudge stems from a collective decision including all relevant stakeholders. Third nudgers can show evidence that they're legitimated, like having a role empowered by a democratic institution or professional function.
Ethical concerns raised by the application of the nudge	A nudge can have unwanted side effects (a defibrillator saves lives, but might cause more harm to people who do not want to be helped). Nudges can recognize this, while providing counterbalancing reasons (the option for signing a 'do not resuscitate' form).

7.4. Appendix D – When do nudges fail?

An elaboration on why nudges can fail, as described in 4.1.4 (Caraban et. al., 2019).

Reason	Rule	Example
Nudging effects not sustaining over time	1. Lack of educational effects 2. Habituation	1. double side print works until single side is the default option 2. Graphic warnings lose resonance over time
Unexpected effects & backfiring	1. Unexpected interpretation 2. Compensating behaviour	1. Energy consumption feedback: when people who use below average start to use more 2. Increasing calorie intake along with physical activity
Intrusiveness and reactance	1. Privacy	1. Small portion of people actively unrolling from vaccination program after automatic enrolment because they felt their autonomy is taken away
Timing and strength of nudges	1. timing 2. strength	1. showing warning pictures only works before the act of smoking, not during 2. If an opt out option is easily available, people will opt out
Strong preferences and established habits *If choosers ignore or reject ,it is because they know best*	1. Nudging works best for people without strong preferences and established habits	1. Opting for healthier food choices is difficult with people with strong habitual foods, similar to opinions about vaccination.

7.4. Appendix E – The Framework

STEP 1
The first step is to analyse what type of health your user might need.
A guide on how to do this can be found in the introduction and appendix A.

STEP 2
The following option is determined by the level of implementation in society.
By implementing design elements within all levels the most effectivity can be established.

STEP 3
The last step is a division of scale of the design elements. The tool can be used within a design process as well as after completion.

DESIGN design elements (check the boxes to find design elements)	HEALTH TYPE mental	social	physical	HEALTH LEVEL individual	relational	communal	societal	SCALE building	surrounding
	✓	☐	☐	✓	☐	☐	☐	✓	☐
fitness area	✓	☐	✓	✓	☐	☐	☐	✓	☐
shading system	✓	☐	☐	✓	☐	☐	☐	✓	☐
public art	✓	✓	☐	☐	☐	✓	☐	☐	✓
food garden	✓	✓	✓	☐	✓	☐	☐	☐	✓
walking trail	✓	☐	✓	☐	☐	☐	✓	☐	✓
inviting staircase	☐	☐	✓	✓	☐	☐	☐	✓	☐
drinking fountains	☐	☐	✓	✓	☐	☐	☐	☐	✓
puclic amenities	☐	✓	☐	☐	☐	✓	☐	☐	✓
smoke free spaces	☐	☐	☐	✓	☐	☐	☐	☐	✓
bike service	☐	☐	✓	✓	☐	☐	☐	✓	☐
lighted streets	☐	✓	☐	☐	☐	✓	☐	☐	✓

By crossing the boxes within health type, health level and scale the design elements are highlighted. After this the filters can be applied to order the boxes from z to a. This places the design elements that meet your criteria to the top. In the example above the design elements 'fitness area' and 'shading system' work best for improving mental health on an individual level using a building design element.

DESIGN design elements (check the boxes to find design elements)	SOURCE academic source (see tab 'sources' below)	reference project (see tab "Reference Projects'below)	findings
fitness area	The City of New York, 2010	Auburn University	Increased physical activity and decreased stress
shading system	Cho, 2015	BE house	Artificial ligths can lead to a distorted sleep rhythm
public art	Abbott, 2013	College Square	decrease in stress levels
food garden	Hale, 2011	DakAkker	Healthy food, social interaction and surrounding in nature leads to a decrease in stress
walking trail	Schasberger, 2009	NY Highline Park	Increased physical activity and likelihood to walk instead of driving
inviting staircase	Boyd, 2021	IOC	Unity staircase at IOC headquarters has led to a threefold increase in pedestrian movement
drinking fountains	Hickman, 2021	Paris Public Fountains	Increase in physical health (hydration) and decrease in plastic bottle use
bike service	Otero, 2018	Manifesto	Bike sharing services provide health benefits, especially for current car drivers
puclic amenities	Plane, 2013	The Goods Line	Public amenities can increase social inclusion and interaction
smoke free spaces	Fichtenberg, 2002	Rookvrije Generatie	Smoke free spaces encourage smokers to quit or reduce consumtion and decrease intake of second hand smoke
lighted streets	Chalvin, 2017	Luminothérapie	Less criminal activity

On the right the sources that support the findings are shown. Links and citations of these sources can be found in two additional tabs.