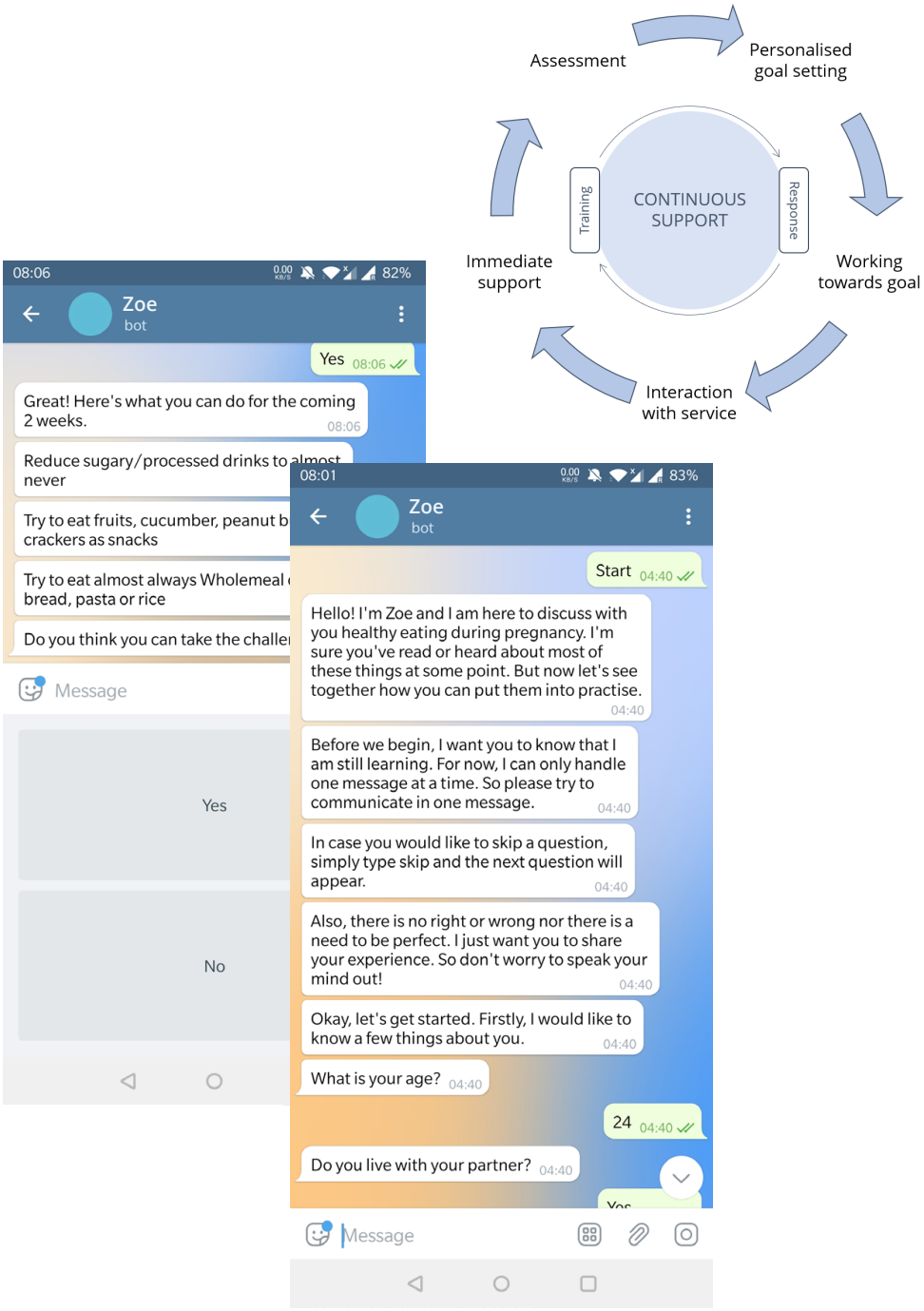
Zoe

Supporting pregnant women with gestational hypertension when bringing about diet change



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Integrated Product Design

MSc. Graduation Thesis

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Erasmus MC
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PREFACE

Here I present you with the deliverable of my graduation thesis for the Medisign specialization at Industrial Design Engineering, TU Delft.

With this project, I decided to put myself outside the comfort zone and explore the strategic side of design more as compared to the technical projects so far. While the journey has not been so easy, it has given me immense learnings in conducting design research and project management. I would like to thank everyone who has been a part of this process and helped me in it.

Firstly, I would like to thank my supervisory team for giving me the opportunity to work on this project. Thank you, Maaike for believing in me and advising me throughout. Thank you, Ki-Hun, for all your detailed feedbacks and constant support. Thank you, Babette, especially the medical-related advice, it has been very useful.

I would also like to thank Lenie for taking out time for me and providing guidance.

A special thanks to Arpita, Varun, Samhita, Tom, Yaman and Parshva for thier endless support when I needed it the most.

Finally, none of this would have been possible without the love and support of my parents. Thank you for everything!

-Rucha Khot

EXECUTIVE SUMMARY

Hypertensive disorders of pregnancy that include gestational hypertension are seen to complicate pregnancies worldwide. Even if hypertension resolves postpartum, these women are at an increased risk of developing cardiovascular issues in the future. So, they are recommended lifelong lifestyle changes that include making adjustments to their diet.

Although the hypertensive pregnancy offers an opportunity for positive change due to high motivation, various challenges get in the way of implementing change. Additionally, an individualistic and personalised approach is required to facilitate the adoption of healthy eating. However, the current setup to support women in the change-making process does not cater to this. A data-driven eHealth service has the potential to provide personalised support and therefore can prove to be useful for guiding women with gestational hypertension in making the required diet modifications.

This graduation thesis was set up with the aim to design the concept of a service that provides personalised support to women with gestational hypertension and help them realise the prescribed diet changes. The design process was guided by the formative research on the challenges and enablers to diet change relating to pregnancy as reported in the literature followed by translating them into providing continuous care by applying behaviour change theories.

As a solution direction to providing personalised support, it is envisioned that women with gestational hypertension will be supported using a chatbot-driven service that assists them in effectively managing their diet by providing continuous training based on their lived experiences and with the help of relevant triggers. The chatbot was developed with the aim to (1) help the women cope with emotions, (2) provide knowledge and (3) effectively manage their diet.

The chatbot serves as a tool to gather data from the women, uncover it and deliver continuous support. In the process, it improves the current care pathway by providing (1) immediate response without increasing the load on the medical team, (2) ease of interaction through uninterrupted contact and increased reach and (3) personalisation of care utilizing tailored support. Thus, it has the potential to act as an effective means for guiding women when making diet changes while catering to specific needs within a diverse population. Further analysis through user testing is required to understand its acceptability and desirability in everyday use.

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Chapter 1

INTRODUCTION

1.1 Background

Hypertension is seen to complicate 7-10% of all pregnancies and pre-eclampsia, a form of hypertension with the presence of proteins in the urine, affects 2-8% of pregnancies worldwide (Duley, 2009; Magee et al., 2009). Overall, hypertensive disorders of pregnancy remain a leading cause of maternal and perinatal morbidity and mortality (Joseph et al., 2010; Mcclure et al., 2011).

Although the cause of hypertension in pregnancy is still unknown, it is possible to control the adverse outcomes during pregnancy by early detection, proper management and adopting a healthy lifestyle that includes a balanced diet consumption (Ouasmani et al., 2018). Additionally, even if the elevated blood pressure levels drop back to normal postpartum, these women are at increased risk of developing cardiovascular disease in the future (Garovic et al., 2010; Ying et al., 2018). Therefore, it becomes important for women with hypertensive disorders of pregnancy to not only adopt healthy behaviours in the short term but sustain them for a lifetime.

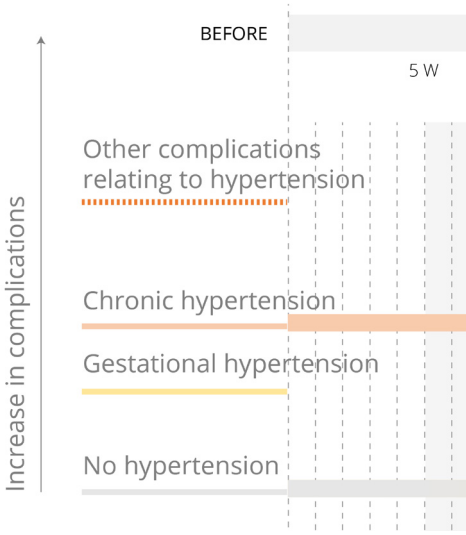
Literature has identified the application of behaviour change theories for altering diet habits by providing education, motivation, and improving the capability of individuals to be effective (Swinburn & Egger, 2002). eHealth interventions that have implemented such theories have shown positive results in altering behaviours in the long term (Van Dijk et al., 2016). Hence an eHealth service that makes use of behaviour change theories is a promising approach when designing for dietary behaviour change in hypertensive women.

In an effort to design for preventive care using emerging technology, specifically the Digital Twin technology, researchers from TU Delft and Erasmus MC are working together on the “my digital twin” flagship project (Bemd, 2020). This thesis project was set up under the flagship to demonstrate the use of data from a hypertensive pregnant woman when designing a service that provides her with personalized care.

Blood pressure is a quantitative trait in humans that largely varies based on various factors like age, sex, circadian rhythm, BMI, physical activity, psychological stress, hormonal status, and sodium and potassium intake (Rossier et al., 2017). Unlike glucose levels in the blood, the impact of diet behaviour on the blood pressure changes may not necessarily be visible in the short term. Research has found the use of emerging technology like that of digital twins to provide preventive, precision care by using health data from a person (Benson, 2021). Thus, the right combination of technology and behaviour change techniques in an eHealth service can provide the required push when changing dietary behaviours in hypertensive pregnant women.

1.1.1 Hypertensive disorders of pregnancy

A woman is diagnosed with hypertensive disorder of pregnancy when the blood pressure reading is at least 140/90 mm Hg on two or more occasions spaced at a minimum of 6 hours apart (Leeman & Fontaine, 2008). These disorders have been classified as Chronic Hypertension, Gestational Hypertension, Preeclampsia, Chronic Hypertension with Superimposed Preeclampsia and HELLP Syndrome (Visintin et al., 2010; Ying et al., 2018). Each condition with a brief description has been explained in Table 1.



Type	Description
Chronic hypertension	Elevated blood pressure before 20 weeks gestation or lasting post 12 weeks delivery
Gestational hypertension	Elevated blood pressure post 20 weeks gestation and without other organ dysfunction
Preeclampsia	Elevated blood pressure post 20 weeks gestation and with proteinuria or other organ dysfunction
Chronic hypertension with superimposed Preeclampsia	Symptoms of preeclampsia in addition to chronic hypertension
HELLP Syndrome	Haemolysis, elevated liver enzymes, and low platelet count

Table 1: Types of hypertensive disorders of pregnancy

The types of hypertensive disorders of pregnancy are separated by varying levels of severity and the involvement of multi-organ dysfunction. Figure 1 shows a visual relationship to illustrate the transition between these types. It does so with the help of 4 levels as an indication of the severity of hypertensive disorder of pregnancy- healthy levels that are an indicator of normal BP, Gestational Hypertension, Chronic Hypertension, and other complications that include preeclampsia, chronic hypertension with superimposed preeclampsia and HELLP syndrome.

The visualization in Figure 1 identifies 4 pathways for hypertensive disorders of pregnancy :

1. Chronic hypertension from before pregnancy or diagnosis of elevated blood pressure levels before 20 weeks gestation
2. Development of hypertension post 20 weeks gestation where the elevated blood pressure levels return to normal post-pregnancy
3. Development of hypertension post 20 weeks gestation where the elevated blood pressure readings last 12 weeks after delivery and the woman is diagnosed with chronic hypertension
4. Other complications of hypertensive pregnancy including diagnosis of pre-eclampsia or HELLP syndrome. These can be represented by pathways marked as a, b and c, where:

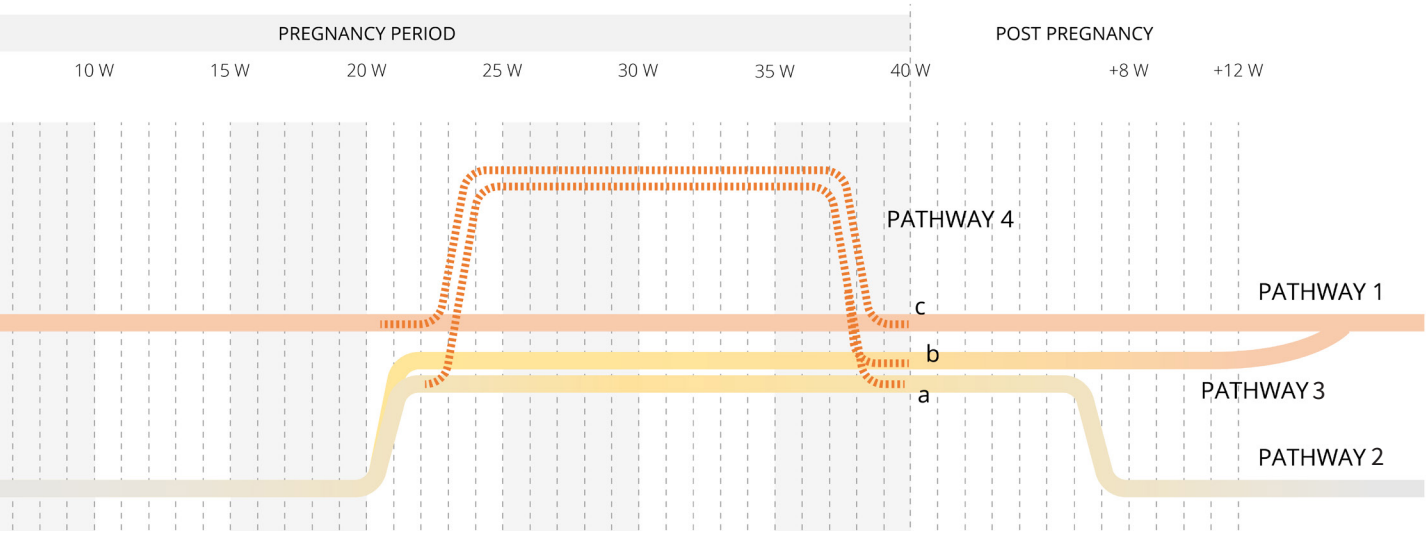


Figure 1: Pathways of hypertensive pregnancy

a. Gestational hypertension further develops additional complications that last up to delivery. The blood pressure levels return to normal by 12 weeks postpartum.

b. Gestational hypertension further develops additional complications. These complications resolve after delivery however the blood pressure levels are elevated beyond the normal range beyond 12 weeks postpartum and the woman is diagnosed with chronic hypertension.

c. Chronic hypertension further develops additional complications that resolve after delivery, and the woman continues to have chronic hypertension.

1.1.2 Dietary lifestyle change as a form of long-term treatment

Hypertension in pregnancy provides an early indication for potential future cardiovascular risk and thus offers a chance to take the necessary corrective steps when there is still time (Ying et al., 2018). For this, the women are advised lifelong lifestyle changes that begins during pregnancy and are called for routine check-ups after delivery. As the definitive cause of hypertensive disorders of pregnancy and its definite relation to future cardiovascular risks is still unknown, there is a variety of guidelines for intervention and management. Table 2 summarises the recommendations for the prevention of future cardiovascular disease from- ACC/AHA (Whelton et al., 2018), ACOG (Obstetricians & Gynecologists, 2013), ESC (Committee, 2003) and NICE (Visintin et al., 2010) guidelines.

Although different, they agree upon early identification through regular monitoring and changing lifestyle to mitigate risk factors for future heart disease in women. Making lifestyle modifications requires an individualistic approach such that it caters to and adapts according to an individual's choice. This is possible for recommendations like weight management and regular exercise. However, the guidelines lack specificity for diet change that makes incorporating changes difficult (Ying et al., 2018). Additionally, the elevated motivation

levels during the time of pregnancy to bring about a positive change gradually fall as the woman return to routine life (Olander et al., 2016), more so in the case of Pathway 2, where the woman develops gestational hypertension that resolves post-delivery.

Thus, there is a need to look into promoting diet change for women who have been diagnosed with gestational hypertension during pregnancy such that the change lasts beyond pregnancy.

Guideline	Hypertensive Disorder of Pregnancy	Suggested Recommendations
ACC/AHA	Gestational Hypertension Preeclampsia	• DASH diet or similar • Weight management • Regular exercise • Detailed patient history relating to complications of pregnancy
ACOG	Repeating Preeclampsia	• Yearly assessment post-pregnancy • Regular physical activity • Weight maintenance • Give up smoking
ESC	Gestational Hypertension Preeclampsia	• Regular BP checks • Control of metabolic factors • Lifestyle modifications
NICE	Gestational Hypertension Preeclampsia	• Inform women of increased future risk • BMI management

Table 2: Recommendations in guidelines for the care of hypertensive disorders of pregnancy

1.2 Design assignment

As stated previously, it is important for women who have developed gestational hypertension to make lifelong positive changes in their lifestyle that includes consuming a healthy and balanced diet, even when hypertension resolves. Such changes require an individualistic and personalised approach to prove fruitful. It is with the interest of this thesis project to design a service for women with gestational hypertension that provides them with personalised guidance and helps them follow the prescribed advice such that the adopted change lasts beyond pregnancy. A key requirement of the project is to provide a tangible solution by utilizing the data of the women and demonstrating its use in informing the design of a service when providing personalised care.Based on this, the project aims to answer the following primary research question:

How might we design a service that helps women with gestational hypertension to implement the prescribed diet changes by providing personalised support?

To design the concept of a service that provides personalised support to women with gestational hypertension and helps them realise the prescribed diet changes.

1.3 Design approach

Considering design assignment and the duration of the project, the double diamond framework was used to guide the process (Council, 2017). The divergence and convergence of the two diamonds allowed for sufficient exploration of the topic while still staying relevant to answering the formulated research question.

DISCOVER:

The Discover phase focuses on holistically understanding hypertensive pregnancy as a moment to promote the consumption of a balanced diet and the challenges associated with it from a user-centred perspective. Finally, as a solution to the proposed problem, an opportunity in the form of providing continuous care using a service intervention has been identified.

DEFINE:

This chapter defines aspects that form the basis of the design of the mHealth service using a chatbot. It takes forward the learnings from the Discover phase and integrates insights on change-making with relevant behaviour change models. The Define phase concludes with the formulation of the design vision and metaphor for the service experience to inspire the further design process.

DESIGN:

The Design phase brings together the learnings from the first diamond and uses it to ideate different aspects of the service. A model for continuous care is proposed followed by designing the structure of the service and the different phases and features that come under it.

DELIVER:

On defining the scope for implementation, the Deliver step looks at the prototyping of the service. The approach of building the chatbot has been explained in detail. The design process concludes by providing takeaways for future implementation.

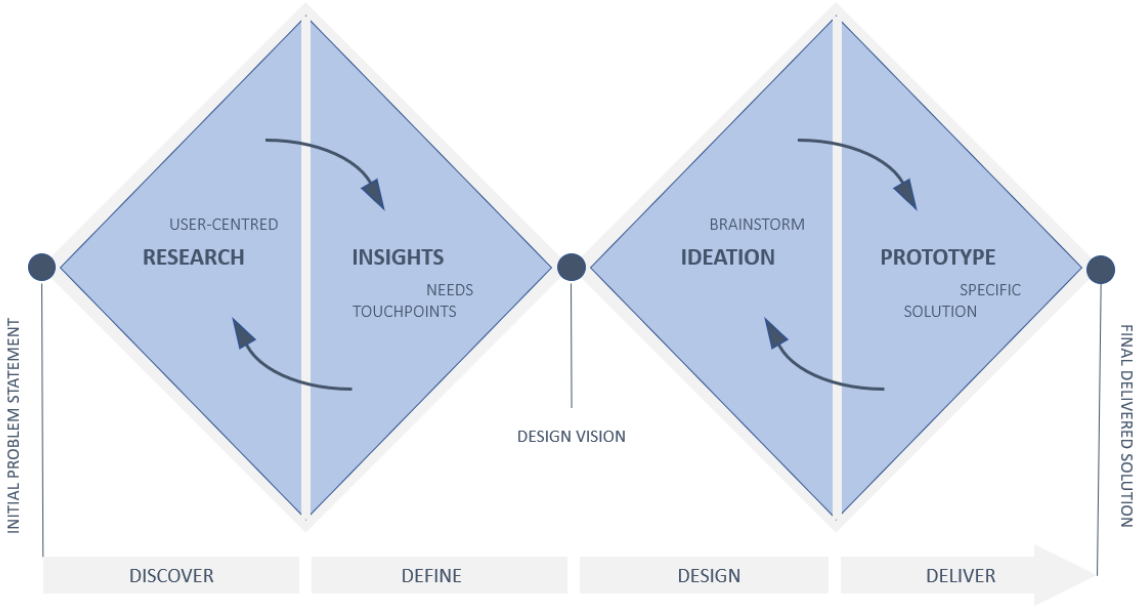


Figure 2: Design approach

Chapter 2

DISCOVER

This chapter focuses on holistically understanding hypertensive pregnancy as a moment to promote the consumption of a balanced diet and the challenges associated with it from a user-centred perspective. Following this, through literature study, various problems associated with facilitating diet change during hypertensive pregnancy are identified. This has been translated to define an opportunity for the service that could provide continuous support by utilizing the identified teachable moments as a starting point. Finally, various communication channels and the use of technology for the service intervention have been discussed and chatbot has been finalized as the mode for the service.

Goals of the Discover Phase:

- Zoom out and look at hypertensive pregnancy as a time for introducing change
- Identify problems in facilitating diet change during pregnancy
- Suggest an opportunity for the service
- Select a suitable mode for the service intervention channel

2.1 Hypertensive pregnancy- a time for change

2.1.1 Teachable moments of pregnancy

Life-changing transitions like health events bring with them high levels of motivation that have the capacity to push an individual to adopt healthy behaviours that reduce possible future risks (McBride et al., 2003). Such life events have been classified as teachable moments and can be seen as opportunities to educate and guide an individual towards making positive behaviour changes (Lawson & Flocke, 2009). A teachable moment is characterised by 3 elements (McBride et al., 2003) as shown in Figure 3.

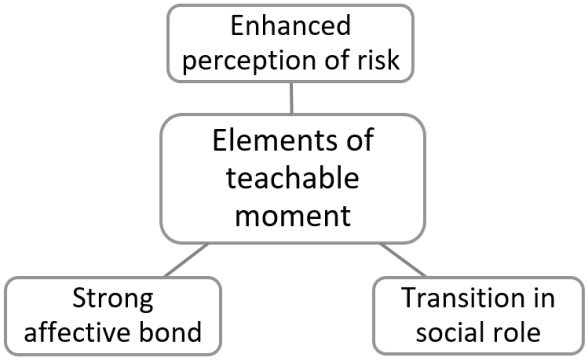


Figure 3: Elements of a teachable moment

Based on this characterization, pregnancy has been classified as a teachable moment and specific events under it have been identified (Olander et al., 2016). Table 3 lists these teachable moments in relation to the pregnancy timeline.

In addition to the above moments, it can be said that the specific event of developing hypertension in pregnancy fits in line with the above classification of a teachable moment, because:

1. The woman has developed an enhanced perception of the risk of her lifestyle choices to her own and her baby's health

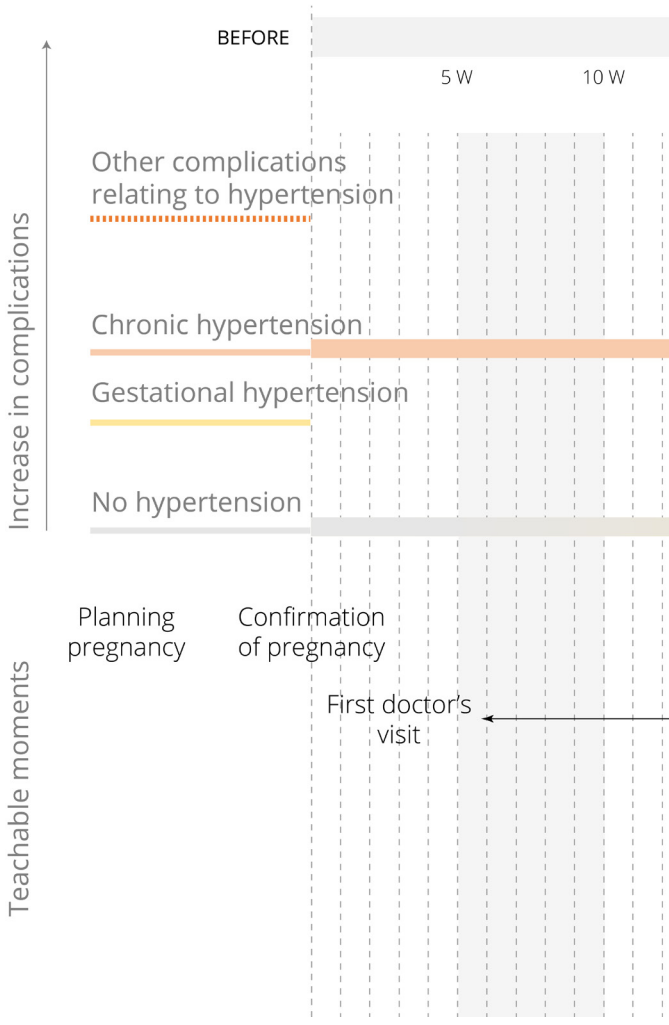
2. She is not only experiencing a strong affective bond with the foetus but also an emotional response in the form of fear for the well-being of the yet to be born child

3. She is transitioning into the role of becoming a mother with the desire of becoming a role model for the child and aiming to provide the baby with the best

Thus, pregnancy and in particular the event of hypertension can be considered a big opportunity for promoting positive changes in diet and educating the women on aspects of nutrition as the women are more receptive to advice due to the elevated motivation levels.

In the context of a woman diagnosed with gestational hypertension, the onset of hypertension is confirmed at the routine check-ups that happen post-20-week gestation. Gestational hypertension that does not become chronic is usually confirmed at the postnatal check-up of 6–8-week post-partum. The period in between these two events offers increased contact points with the healthcare providers and an added desire to bring about a positive change for the love of the yet to be born child. Collectively, these moments can be leveraged upon for promoting positive changes in the diet.

Figure 4 shows the representation of teachable moments from Figure 1 and additional moments in relation to gestational hypertension (Pathway 2) taken forward from Table 3.



	Teachable Moments
Pre-pregnancy	Baby planning phase
Pregnancy	Confirmation of pregnancy
	First doctor's visit
	Routine medical check-ups
	Experiencing foetal movements
	Scans of the baby
	Delivery
Post-pregnancy	Breast-feeding phase
	Postnatal check-ups
	Maternity leave ends/getting back to routine
	Weaning

Table 3: Teachable moments of pregnancy

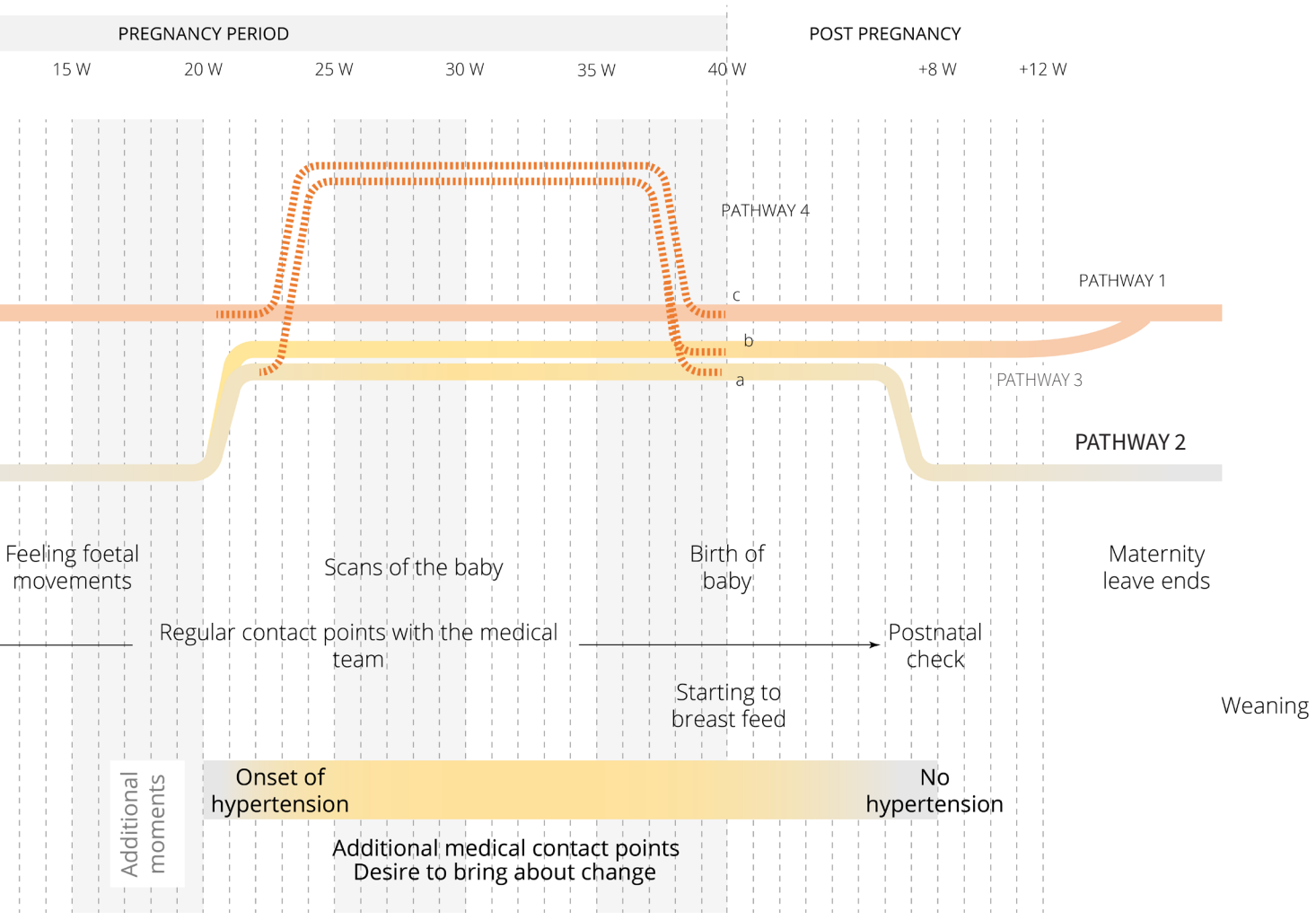


Figure 4: Teachable moments of pregnancy for gestational hypertension (Pathway 2)

2.1.2 Issues when facilitating diet change

Although pregnancy and hypertensive pregnancy, in particular, is considered a teachable moment due to motivation shifts, there are a few situations that may pose as issues when facilitating diet change. These have been explained further.

Pregnancy is a time when a woman sees healthcare professionals at regular intervals for routine check-ups and scans of the foetus. At these meeting points, she is advised and reminded of following healthy behaviours. However, there are several challenges associated with the information received. The counselling offered on healthy eating is perceived as confusing and not individualised by pregnant women (Ferrari et al., 2013). The guidelines for diet change in case of hypertensive pregnancy have been reported to lack specificity (Ying et al., 2018). An unclear understanding of expected changes by pregnant women, a small timeframe for bringing about the change and the struggles when eating healthy in social gatherings can get in the way of eating healthy during the hypertensive pregnancy (Carolan et al., 2012). Collectively, the emotional and psychological impact of an undesirable situation and the lack of opportunity to execute changes in behaviour due to physical or social limitations could neutralise the positive effects of elevated motivation (Olander et al., 2016).

Additionally, health advice is often interpreted in combination with preconceived notions and beliefs, the experience and advice of close friends and family and information obtained from the media like books, magazines, and online pregnancy forums (Clarke & Gross, 2004). In case these conflict with the advice of the healthcare providers, it may become a topic of concern particularly in the context of hypertensive pregnancy. Overall, the advice given by the health professionals can be visualised as coming in bursts and also at a time when the women might not be best receptive to such information and so, such interaction moments have been identified as underutilised opportunities (Talbot et al., 2018).

Finally, after delivery, there is a shift in the perception of risk to health to the joy of giving birth. As the women are adjusting to the new life with the newborn, old routines are replaced by new ones and the time and attention given to self-care are prioritised below the child's needs (Mercer, 1985). Research has indicated poor time management, increased stress due to a feeling of loss of control over one's life, irregular sleep and post-partum depression as a few factors affecting the wellbeing of women (Cheng et al., 2006). This may have a direct effect on the food that is consumed thus affecting the health in the long term. All in all, it can be said that though the teachable moments of pregnancy can be leveraged to promote the adoption of healthy eating habits, they may not be sufficient to sustain positive diet changes.

2.1.3 Making change a part of life

The motivation wave proposed by Fogg suggests a concept that can be applied to the context of hypertensive pregnancy when implementing continuous support. The concept proposes, "When motivation is high, you can get people to do hard things. But once it drops, then people will only do easy things" (Fogg, 2021, January 16) and is represented by the motivation time curve in Figure 5.

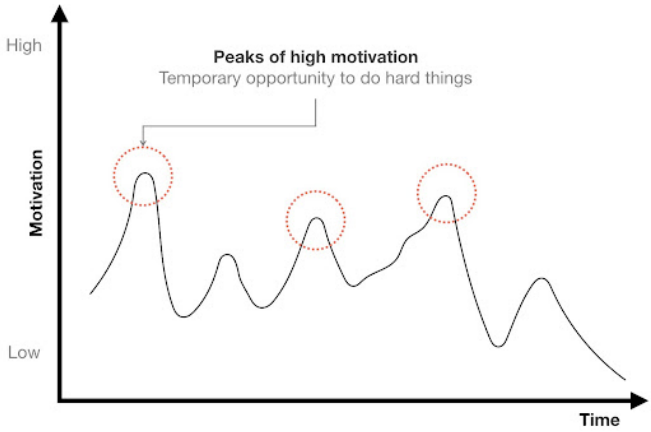


Figure 5: Fogg's motivation wave (Fogg, 2021, January 16)

In relation to gestational hypertension, the moment of highest motivation as highlighted for Pathway 2 is the diagnosis of hypertension that brings with it the desire to bring about a change and increased contact points with the medical team. The event of diagnosis can be used as a starting point to introduce the intervention for continuous support. During the interactions with the intervention, the desire to bring about a change can be leveraged to help the women maintain the change while the increased contact points with the medical team can be used as secondary points to re-iterate the need for a dietary lifestyle change. Eventually, as the woman is adjusting to the new life with the baby and beyond, the motivation to bring about change reduces as other priorities take their place. However, at this stage, if consuming healthy meals has become a part of everyday routine, then it will come across as an easy task that does not require high motivation levels as suggested by Fogg. This has been illustrated in Figure 6.

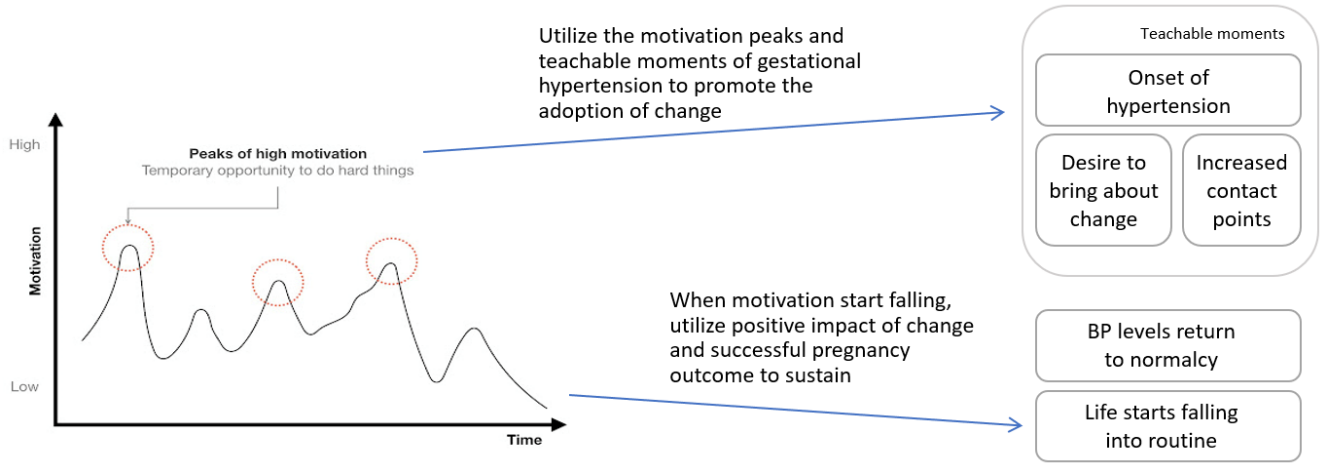


Figure 6: Applying Fogg's motivation wave to gestational hypertension- Pathway 2

Key Points:

- For gestational hypertension, the key teachable moment is the event of diagnosis of hypertension followed by the increased contact points with the healthcare professionals.
- Teachable moments highly rely on elevated motivation levels and offer an opportunity to introduce change as the women are more receptive to advice, but they may not be sufficient in itself.
- For Pathway 2, the period in between the event of diagnosis of hypertension and the confirmation of it not becoming chronic can be leveraged upon for promoting the adoption of new change due to the added desire to provide care for the child.
- The change should be promoted such that it becomes a part of everyday life so that it lasts after delivery even when the motivation levels may not be so high.

2.2 OPPORTUNITY FOR SERVICE

Through the journey of pregnancy, the woman is in contact with her healthcare team that includes her gynaecologist, midwives, dietitian, cardiologist, and the general practitioner post-pregnancy. On the days of the scheduled appointments, the woman reports to the healthcare professionals and in turn, they provide her support in the form of health-related advice and the required treatment. This interaction has been visualised in Figure 7.

Now, once the woman is provided with the necessary support, it is expected that she takes the required steps for implementing the prescribed changes until the next appointment. At the next visit, she reports the progress on the recommended advice and her health status is re-evaluated. Thus, it can be seen as a cycle of report and support that repeats after a certain time interval and after delivery, this time interval increases. As mentioned in the previous

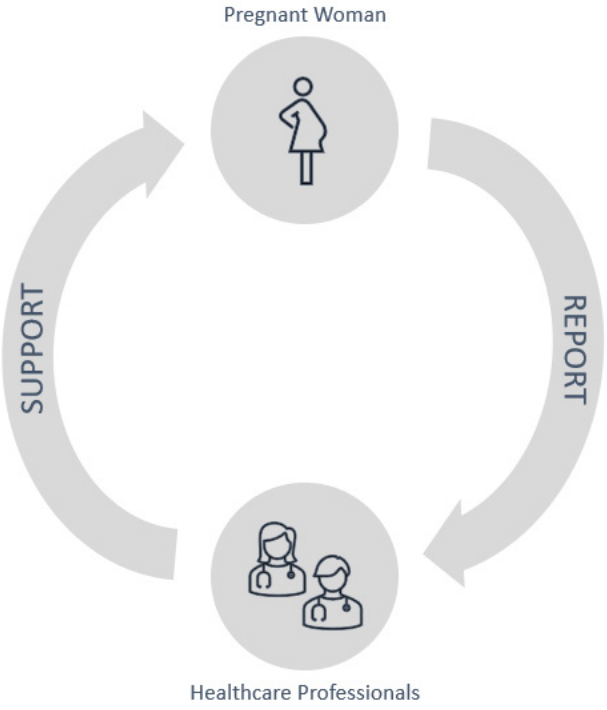


Figure 7: Interaction of pregnant women with healthcare professionals

section, pregnancy offers a good time for change due to the elevated motivation levels. However, they may not be sufficient to bring about and sustain the prescribed diet changes due to various situations that act as barriers to diet change. Women can be motivated towards change by the advice of healthcare providers and using pregnancy as the moment for change, but they need continuous support for implementing those changes and maintaining them (Baird et al., 2009). The current setup lacks such continuous support and so making changes to the diet and ensuring that they last beyond pregnancy is not guaranteed.

The everyday management of activities expected from pregnant women for following the prescribed advice for diet change falls under the domain of self-management of an illness (Grady & Gough, 2014). Self-management and quality care provided are interdependent and go hand in hand in the long-term management of a medical condition (Bodenheimer et al., 2002). This means that self-management in the absence of quality healthcare service or the other way round will not aid in the effective management of the health. To tackle this by designing a better care delivery system, an approach to providing continuous care has been proposed (Zhao et al., 2020). The approach proposes to make use of continuous data from the patients, even when they are healthy, to provide them with the required support and personalize treatment based on their body's response (Zhao et al., 2020).

Therefore, it can be said that a continuous care approach when applied to the context of supporting women with gestational hypertension for helping them bring about the required diet changes could prove to be effective, especially in helping them sustain changes in the long run. Figure 8 illustrates the above proposition by providing continuous support to the women in between the appointments with healthcare professionals to fill in the current gap. The following section will look at ways in which continuous support can be provided to the woman by leveraging technology and using it as a channel for the service intervention.

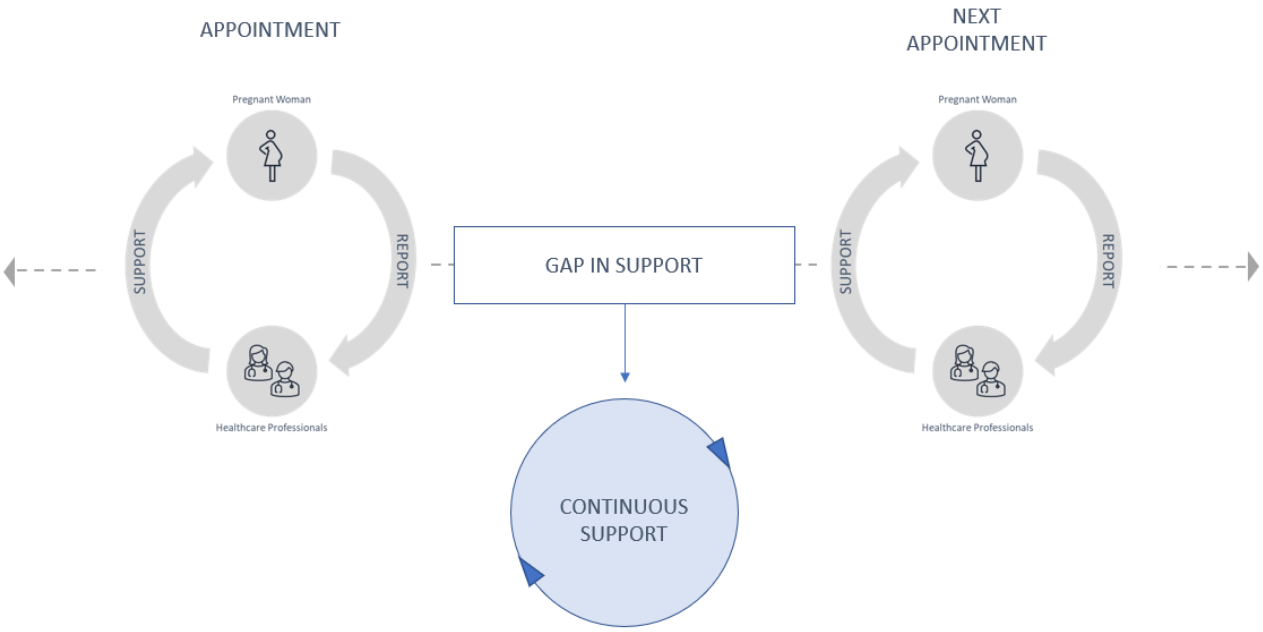


Figure 8: Proposed care path of a pregnant woman through continuous support

2.2.1 Service intervention channel

There is a rise in the use of technology for facilitating a healthy lifestyle using interventions that aim to make healthy behaviour habitual (Orji & Moffatt, 2018). Such interventions targeting diet change have shown positive results in the context of pregnancy (O'Brien et al., 2014). In most cases, these interventions primarily make use of a digital or a mobile platform to interact with the target group and involve secondary interaction of healthcare professionals (guideline NG183, 2020). Such an approach to care has made the process of providing support more feasible by maximising reach and impact with the same or fewer contact hours of healthcare professionals (O'Brien et al., 2014). In addition to this, it has made tailoring content for an individual's needs possible as more is known about the users from their everyday life (Yardley et al., 2015).

Successful studies that have implemented a digital or a mobile platform have made use of messages sent in the form of text and/or audio on smartphones, wearable devices to collect and/or communicate, interaction via the internet by email, website, apps or social media, an interactive interface like chatbots with textual or voice response and virtual or augmented reality (guideline NG183, 2020). With most people having access to the internet on their smartphones, digital interventions that make use of smartphones as a medium for promoting behaviour change have the potential to reach a large chunk of the population (Okorodudu et al., 2015). Given the affordability, portability and convenience of use, interventions making use of smartphones have proven to be effective in promoting behaviour change (Dennison et al., 2013). Such interventions are classified under mobile health or mHealth interventions.

Within the domain of mHealth interventions, those that use additional human support have proven to be effective in increasing engagement and motivation with users (Dennison et al., 2014). Such interventions make use of collaborative support provided by a combination of humans and technology. However, this calls for more work or increased labour from the healthcare system thus increasing the cost of care.

In recent years, chatbots that make use of Artificial Intelligence in the form of Natural Language Processing, have been able to replicate human-like conversations when resolving customer queries (Maedche et al., 2019). An intervention that makes use of such an approach is adaptive, learns and improves over time and thus has proven useful in the context of healthcare. Thus, when considering a medium for intervention channel for the service, conversational agents in the form of chatbots could be the best fit.

Thus, an intervention built using a chatbot setup has the potential of understanding the barriers faced by women in real-time and suggesting the best-suited advice while adapting through the lived experience of women. This approach has a two-way benefit- it helps reduce the workload on the healthcare system while providing women with personalised support and care. To summarise, the use of chatbot has the potential to deliver continuous care by focusing on 3 elements:

1. automation of response by the interface to provide immediate support without increasing the load on the medical team
2. ease of interaction to ensure uninterrupted contact and increased reach
3. personalisation of care by providing tailored content

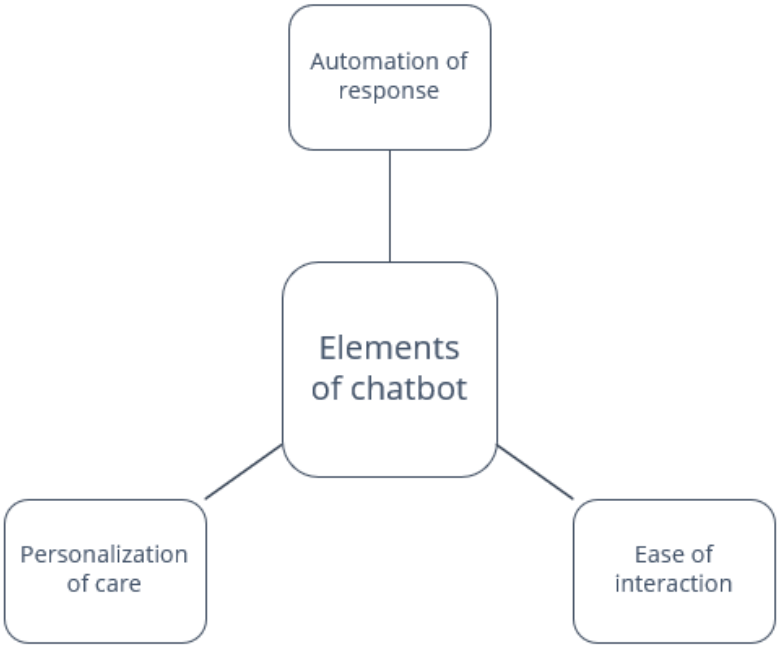


Figure 9: Requirements for delivering continuous care

Key Points:

- A continuous care approach that supports the women could prove to be effective in helping them bring about the required diet changes. This support would fill in the gap between appointments by guiding the women in integrating change into their routine.
- Digital interventions offer increased reach and smartphones, in particular, are affordable, portable, and convenient to use, thus making mHealth interventions a suitable choice for the service.
- The delivery of continuous care requires- automation of response, ease of interaction, and personalization of care to prove useful. This can be collectively achieved by using a chatbot as the channel for the service intervention.

Chapter 3

DEFINE

This chapter defines aspects that form the basis of the design of the mHealth service using a chatbot. For this, first, the insights from the Discover phase have been taken forward to propose the process flow of providing continuous support. Then, diet change has been looked at from a human-centred lens to identify the challenges and enablers to making change and how these could be translated to providing continuous care. This has been done by conducting research on existing literature and implementing behaviour change models. Finally, a design vision has been formulated to guide the following phases of the study.

Goals of the Define Phase:

- Define the process of providing continuous support for diet change
- Identify the challenges and enablers to diet change during the pregnancy period
- Translate these into defining elements for providing continuous care
- Formulate a design vision for the design stage

3.1 DEFINING THE SERVICE MODEL

As mentioned in the formulation of the assignment, a primary requirement of the project is to design a service for hypertensive women by utilizing the data of the women for providing personalised care. The situated design approach has shown successful results when designing interventions that are based on data-driven design (Van Kollenburg & Bogers, 2019) and it can therefore be taken as an inspiration when defining the service model of the project.

As shown in Figure 10, the situated design approach aims to take the users from the "current reality" into a "new reality" by dividing a series of 6 steps into 2 stages- the contextual stage and the informed stage. The contextual stage focuses on gathering insights from the current reality using sensors and prototypes to understand the users. These learnings are taken forward into the informed stage that works towards adapting the system to take users towards the new reality. Thus, the approach makes use of the double loop of exploration that focuses on the exploration of the tool and the solution simultaneously with the help of real-world data (Stienstra et al., 2015).

In the context of the current study, the chatbot poses as the situated prototype

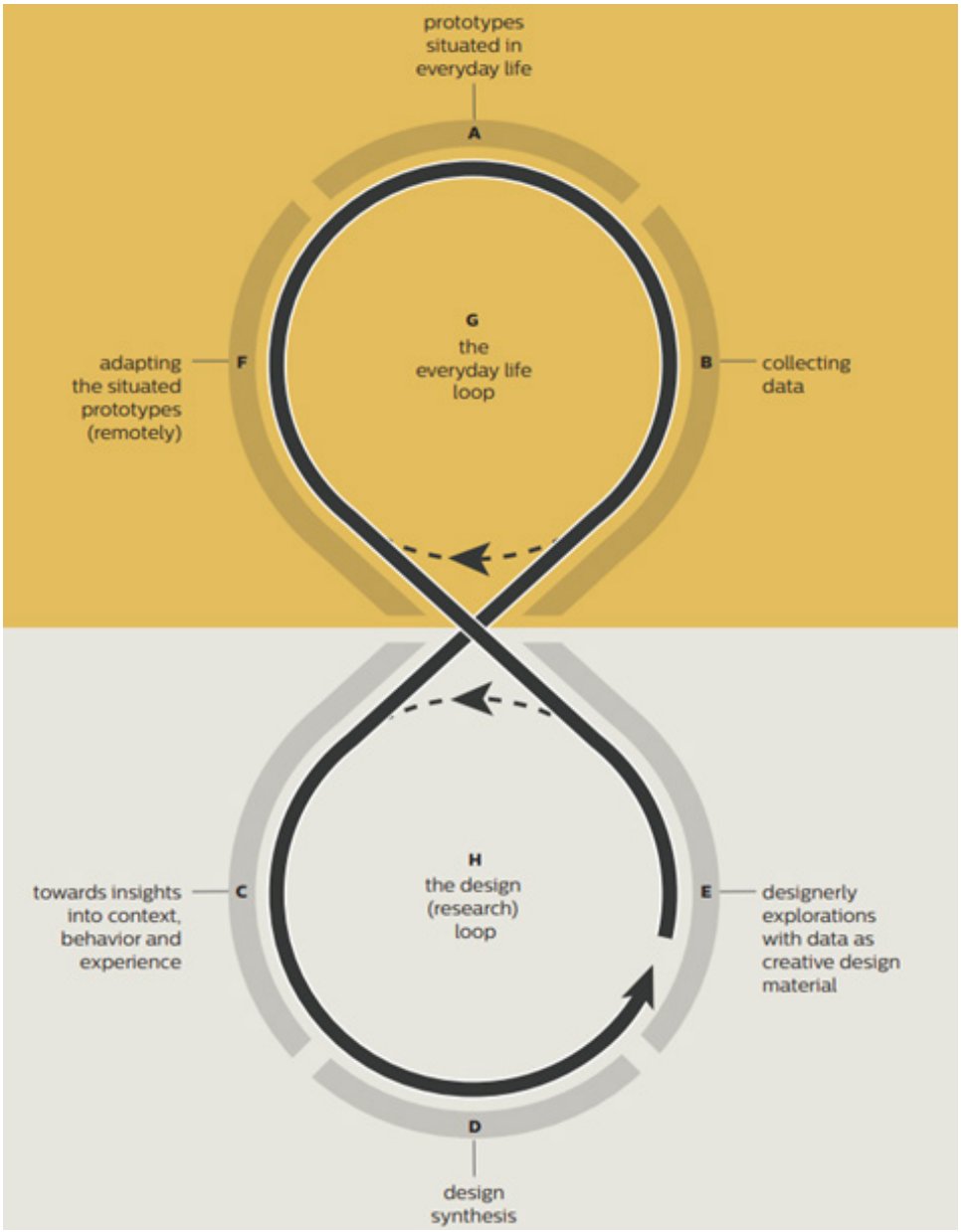


Figure 10: Situated design approach (Van Kollenburg & Bogers, 2019)

and acts as a tool for data collection that can inform the design research loop.
Taking inspiration from the situated design approach, the three elements that the chatbot needs for delivering continuous care can be implemented as shown in Figure 11:

1. The chatbot assesses the current diet pattern of the women
2. Setting goals based on the assessment that are agreed upon by the women
3. The women take the required actions with the aim of achieving the set goals
4. The women interact with the chatbot and update progress
5. The chatbot provides the required support immediately

This process brings forward a training-response cycle. The training is provided to the woman by breaking down the set goal into actionable points for execution. The response by the woman takes two forms- response in the form of her everyday actions and communication with the chatbot. This is again followed by the training that is based on the response of the woman. With this approach, it is possible to deal with the challenges that the woman could be facing by gradually working towards them. With timely help and support, it is possible to take corrective action and limit the medical condition from becoming worse. Eventually, the newly acquired habits can be set into the routine by continual repetition thus promoting a lifelong change.

However, for such a setup to become a reality, the chatbot system needs to adapt based on the response of the woman. For this, it needs to have an understanding of what motivates the woman and what acts as a barrier when bringing about diet change. Prior knowledge of the barriers and enablers to change will prepare the chatbot to provide a response that is most likely based on what has already occurred. Over a period of time, as the chatbot learns more about the woman and her behaviour patterns, it can offer better-personalised advice. Thus, it can provide immediate support without requiring the immediate intervention of healthcare professionals.

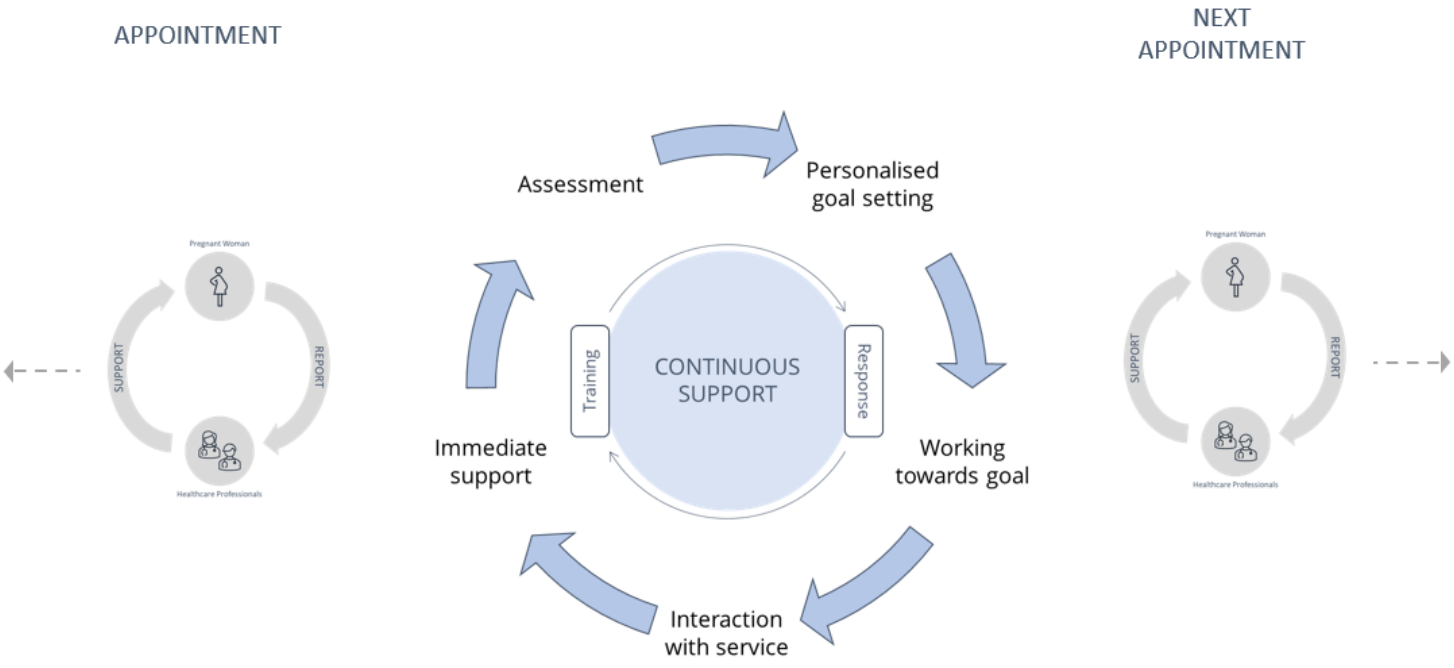


Figure 11: The suggested process of continuous support for diet change

Key Points:

- A cyclic 5-step process inspired by the situated design approach could help realise the opportunity of providing continuous care using a chatbot.
- The chatbot requires prior knowledge on the barriers and enablers to the process of making a diet change in pregnancy to advise the women in the moment based on what they have said.

3.2 INVESTIGATING THE CHALLENGES AND ENABLERS

Goal

A considerable amount of research has been done to investigate the challenges and enablers for pregnant women when they are required to make lifestyle changes relating to their pregnancy. To help empathise with the women better and define the design aspects of the chatbot and its responses, this research can be taken as a starting point. For this, the following sub-research question was formulated:

What are the reported challenges and enablers in the literature for making the required diet changes relating to pregnancy?

Data Collection

The research was conducted to identify literature discussing the challenges and enablers encountered by women when they were prescribed to make diet lifestyle adjustments relating to pregnancy. Table 4 highlights the parameters for search criteria.

Considering the available timeframe of the project, a total of 10 papers were identified as a starting point for the study, 8 of which focussed on diet change (Al-Akour et al., 2015; Ayalew et al., 2017; Berenson et al., 2016; Coonrod et al., 2009; Dunlop et al., 2013; Frey & Files, 2006; Khan et al., 2019; Mitchell et al., 2012) and the remaining 2 were about lifestyle change (Boyd et al., 2020; Muhwava et al., 2019). At this stage, it was decided to continue with the analysis and include more papers to deepen the analysis if required later.

Parameters	Inclusion	Exclusion
Timeframe	Preconception, during pregnancy, after delivery	At other times
Context	Relating to diet change or lifestyle changes that include diet change as one of the factors for women	Other lifestyle changes or targeting the general population

Table 4: Inclusion and exclusion criteria for the study

Data Analysis

The process of data analysis was done in two steps. The goal of each step and the analysis done within each has been discussed in detail below.

Step 1: Systematic categorization of challenges and enablers

To bring together the challenges and enablers from all papers and to guide their systematic categorization, the COM-B framework in combination with the Theoretical Domains Framework (TDF) was followed. The COM-B framework considers the varying levels of three constructs- capability (C), opportunity (O) and motivation (M) to be at the source of driving the outcome of behaviour (B) (Michie et al., 2011). The TDF framework further classifies the three sources of behaviour into multiple domains as shown in Figure 12 thus providing a systematic categorization of the driving forces behind the behaviour. Collectively, they provide a holistic understanding of the challenges and enablers affecting the desired behaviour that helps in adapting to the varying levels in capability, opportunity, and motivation over time by addressing the source of behaviour (Atkins et al., 2017; Flannery et al., 2018).

The challenges and enablers from the papers were listed out and compared to the definitions of the TDF domains within the COM-B framework as stated in Figure 12. Similar challenges and enablers were put together and allocated a common name. The results from the analysis described above are presented in Appendix 2.

The results obtained so far provide a clear overview of the challenges and enablers faced by the women. Additionally, an overlap is observed in the reported results from multiple papers. Thus, the investigation so far was considered sufficient for the first step of the analysis. The next step in the analysis is to look at how the identified challenges and enablers can be made meaningful from the aspect of providing continuous care.

Figure 12: COM-B Framework with Theoretical Domains Framework (Michie et al., 2011)

Step 2: Defining scope and thematic categorization of barriers for identifying needs

The challenges act as obstacles in the path of achieving the desired goal while facilitators take the woman a step closer to the goal. So, to translate these into providing continuous care, the chatbot should be designed to utilize the facilitators as tools of encouragement and challenges as opportunities to provide guidance. This calls for further analysis into identifying the specific needs of the women that the chatbot should be trained to provide guidance.

Additionally, the identified challenges and enablers are an outcome of the dynamic interrelations among multiple factors. Therefore, addressing the challenges requires a diverse set of strategies and approaches that lies beyond the scope of a single intervention. Thus, it is required to narrow down the scope before proceeding with the thematic analysis. For this, it was decided to label the challenges using the contextual domains described by the socioecological model of health (Göran & Whitehead, 1991).

The socioecological model of health categorises behaviours as an outcome of 4 domains- Individual, Relationship, Community and Society such that they go from a micro to a macro level as shown in Figure 13. Such segregation has helped in visualising the challenges and enablers into broader domains and thus simplifying the complexities and narrowing down the scope of the intervention (Control & Prevention, 2018). At the micro-level, the individual domain incorporates the personal characteristics of an individual that impact behaviour. The next domain includes the effect people from the individual's inner circle have on the behaviour and experiences of the individual. The third domain includes impact on behaviour due to the social interaction with people and the environment. Finally, at the macro level, the societal domain includes factors like social and cultural norms and policies that influence behaviour. For the current analysis, the domains are labelled as- Individual, Family, Community and Provision/Policy from micro to a macro level. The results obtained from this stage are shown in Table 5.

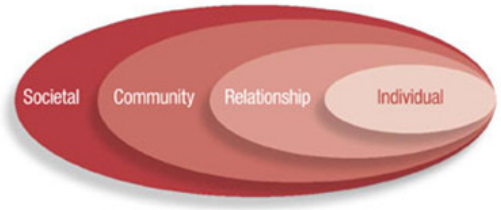


Figure 13: Socioecological Model of health (Control & Prevention, 2018)

Most barriers are seen to fall under the individual domain of the socioecological model. The barriers under this domain have been catered to by providing care directly to individuals (Control & Prevention, 2018). Such a goal is possible to be met using interactions designed with a chatbot and so, it was decided to focus on the barriers corresponding to the individual domain.

Now proceeding with the thematic categorization of barriers to identify the needs of the women that the chatbot should be able to address, the barriers corresponding to the individual domain were critically analysed and compared with each other and put into groups. Once the groups were formed, they were labelled with a central theme defining the specific needs of the women. This lead to the identification of three themes that have been discussed in detail in the results section.

COM-B	Constructs	TDF Domains	Barriers	Category
Capability	Psychological	Knowledge	Absence of knowledge on diet change and health implications	Individual Provision/Policy
			Incorrect information on diet change	Individual Provision/Policy
			Limited resources with generic information	Provision/Policy
			Lack of awareness of making change	Community Provision/Policy
		Memory, attention and decision making	Inability to focus on healthy eating post delivery	Individual
			Lack of long-term decision making and planning	Individual
			Family history, previous diagnosis affects decision	Individual
		Behavioural regulation	Not monitoring progress	Individual
			End of monitoring post pregnancy	Individual
		Cognitive difficulties/skills	Language acting as barrier	Provision/Policy
			Denial of disease and emotional impact of diagnosis reduces information processing ability	Individual
			Lack of self-management of illness	Individual Family Provision/Policy
	Physical	Skills	Purchasing and preparing healthy food	Individual Family
			Physical restriction due to medical conditions or postnatal complications or fatigue reduces mobility	Individual
Opportunity	Social	Social influences	Lack of family support	Family
			Absence of social support and encouragement	Community
	Social/physical	Competing priorities	Limited time	Individual
			Neglecting self or prioritising family over self	Family
	Physical	Environmental context and resources	Limited or inaccessible resources	Provision/Policy
			Financial constraints	Individual Provision/Policy
			Unhealthy convenience food is easily available and better marketed	Provision/Policy
Motivation	Reflective	Beliefs about consequences	Beliefs attached to consequences of eating certain foods in relation to pregnancy	Individual
			Underestimating impact of diet change	Individual
			Lacking motivation to bring about change	Individual
		Beliefs about capabilities	No control over buying foods	Individual
			Lacking self-belief in making change	Individual
			Stress of illness reduces perceived self-efficacy	Individual
			Lacking belief in identifying healthy foods	Individual
		Social role and identity	Illness evokes emotions of failure and threatens image of being ideal parent	Individual
		Intention	Lack of intention to change or intention ends post pregnancy	Individual
		Goals	Lacking goal of eating healthy	Individual
			Absence of call to action or plan	Individual
		Optimism	Preconceived notion based on past experiences of self and family leading to negative thoughts of future	Individual
	Automatic	Reinforcement	Failure in following change and lack of tracking actions creates a downward spiral	Individual
		Emotional response	Stress induced due to guilt of failure followed by answerability to family and healthcare team	Individual
			Overwhelmed by radical changes in a short timeframe	Individual
			Impulse to eat due to pregnancy cravings	Individual

Table 5: Contextualizing the challenges and enablers using socioecological model

Results

The analysis step concluded with the identification of three themes: Emotions (8), Knowledge (4) and Management (11). Figure 14 shows the barriers that come under each theme.

The description of each theme is as follows:

1. Emotions

The challenges faced when bringing about a diet change seem to be largely driven by the emotional state of the women as this directly affects their motivation. This is brought forward from the challenges corresponding to the motivation category of Table 5. The event of diagnosis with hypertension, having to accept it as a lifelong health issue, the deteriorating health condition, and the effect of the medical condition on the unborn child are factors that alter the state of mind of the woman as brought forward from the challenges. Collectively, these events come across as overwhelming factors and act as triggers for worry which becomes the cause of negative emotions. The stress due to these overwhelming factors and pregnancy cravings is also liked with an impulse to eat unhealthy food. To counter this, self-belief, seeing a positive effect of a healthy diet on self and finally, a successful pregnancy outcome can act as an encouragement to consume healthy food. Thus, emotions can have a two-way effect on the desired behaviour change and it is, therefore, important to recognise them and help the women deal with them accordingly.

2. Knowledge

This theme considers all the aspects relating to the information that is required to being about the diet change. It includes an understanding of a balanced diet and the health implications of the current diet in the short and long term. Additionally, it also includes the awareness of current diet and the knowledge of what is expected of them and what they are required to do. Unawareness of these aspects can have a direct influence on diet behaviours. Therefore, it is required to ensure that the women have the necessary knowledge and are informed of their actions and their impact through the process.

3. Management

Poor management or lack of management of multiple aspects in the routine and tracking is an obstacle in the path of implementing diet change. The needs and desires of the family or busy schedule leave less or no time for preparing healthy meals. The shortage of time is often compensated by prioritising other tasks and compromising personal needs. Thus, positive behaviour changes, though perceived to be important are oftentimes neglected or are put off for another “better” time. This is observed even more after delivery. Additionally, varying levels of motivation, a lack of clear goals and not monitoring the change well deter women from choosing the path of healthy behaviour in the long run despite knowing what needs to be done. Finally, when it is diagnosed that the women no longer have hypertension, the importance given to monitoring everyday diet and consciously focusing on eating healthy reduces. Thus, it is important to address the issues relating to planning and effective management of diet and help the women to visualise healthy eating habits to be beneficial to them in the long run.

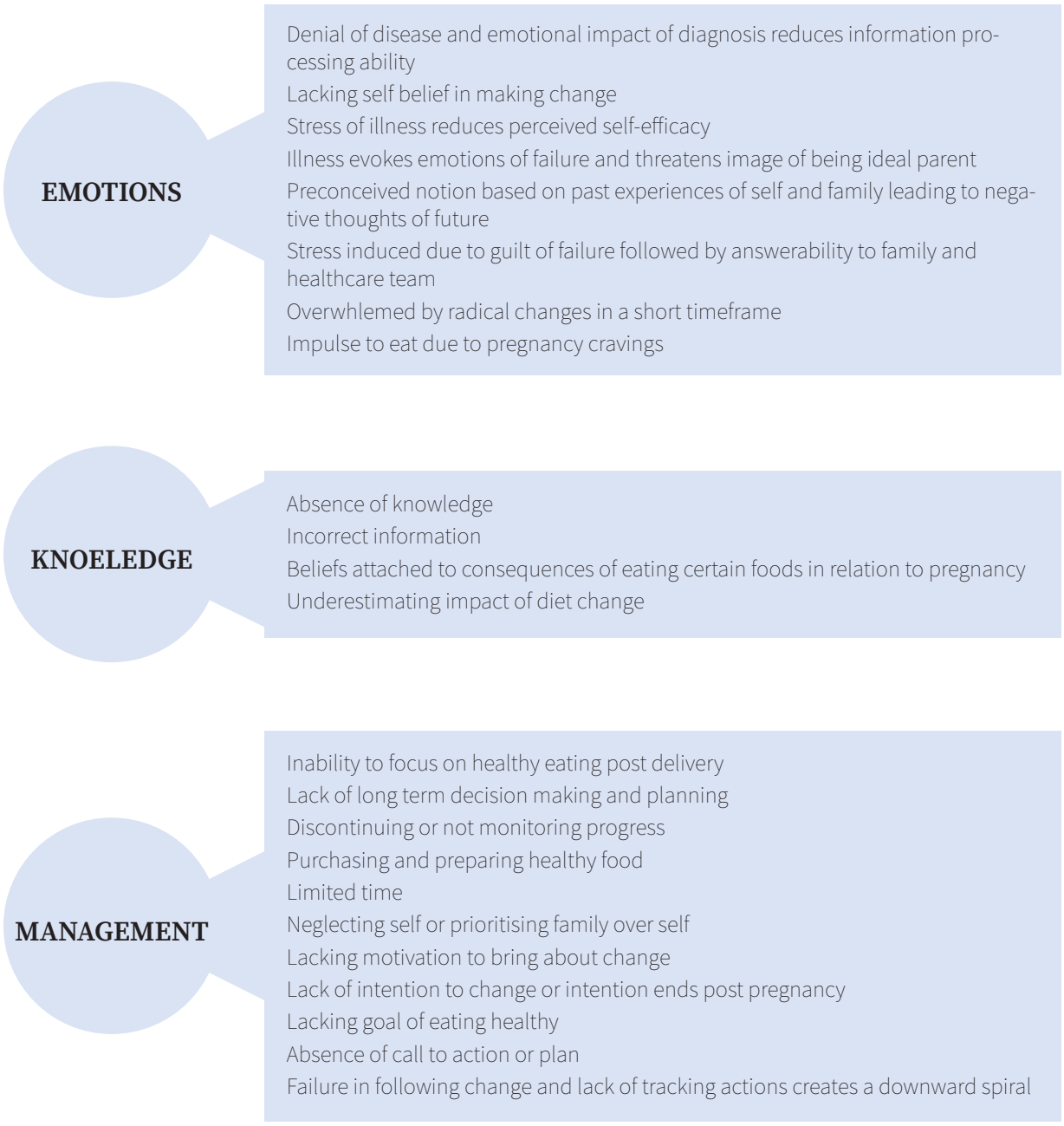


Figure 14: Thematic segregation of identified barriers

Conclusion

The research conducted for this short study has successfully answered the sub-research question:

What are the challenges and enablers reported in the literature for making the required diet changes relating to pregnancy?

The systematic categorization that was done using COM-B and TDF framework helped in identifying the challenges and enablers from the literature. The challenges act as barriers while the facilitators take the woman a step closer to achieving the diet goals. So the barriers can be used to identify the specific needs of the women that the chatbot should be trained to provide guidance.

However, as the challenges and enablers are the outcomes of an influence of a variety of factors, they cannot be addressed by a single intervention. Therefore, by using the domains of the socioecological model, the barriers were contextualised and the scope was narrowed down to the individual domain for the service intervention with the chatbot.

Finally, thematic segregation of the challenges brought forward three themes highlighting the needs of the women. These include- (1) helping the women cope with emotions, (2) gain knowledge and (3) effectively manage their diet.

Further research should now focus on defining aspects of the service that can deliver the required support for the needs within the identified three themes.

3.3 IMPLEMENTING THE CHANGE

As humans, we are resistant to change. The process of bringing about a new change is highly dependent on the ability of an individual to take action. This section will look into how support can be provided by applying behaviour change theories to address the barriers identified in the previous section.

The Transtheoretical Model has been recommended as one of the models for modifying behaviour at an individual level because it focuses on promoting adoption and maintenance of behaviour and preventing fallback that is commonly observed in diet change (Glanz et al., 2015). The transtheoretical model is a combination of the following two constructs- 10 processes of change and 5 stages of change (Weinstein et al., 1998).

1. Processes of change

Processes of change highlight aspects that have the ability to promote transitions between the five stages of change by making use of certain strategies (Prochaska & DiClemente, 1982). Using the description of what each process entails and comparing it to the themes of knowledge, emotions and management, the barriers identified in the previous section have been listed corresponding to the relevant processes as shown in Table 6. As social liberation involves policy changes, it has been neglected when suggesting strategies as the intervention aims at influencing challenges on an individual level.

	Process	Description	Theme	Barriers
1	Consciousness raising	Increasing knowledge of problems and awareness of behaviour, causes and consequences	Knowledge	Absence of knowledge
				Incorrect information
				Preconceived notions that are not true
				Underestimating impact of change
2	Dramatic relief	Experiencing emotions- initially increased emotional response, then relief on action	Emotions	Denial of health condition and emotional impact of diagnosis
				Illness evokes emotions of failure and threatens the image of being an ideal parent
				Stress reduces perceived self-efficacy
				Stress that is induced due to guilt of failure followed by answerability to family and healthcare team
				Living in denial of illness and its impact
				Impulse to eat due to pregnancy cravings
3	Environmental re-evaluation	Understanding impact of behaviour and outcome on others	Management	Inability to focus on healthy eating post-delivery
				Lacking the motivation to bring about change
				Intention ends post-pregnancy
4	Self-re-evaluation	Assessing change as a part of self-image – with and without change	Management	Failure in following change and lack of tracking actions creates a downward spiral
5	Social liberation	Changes in the social opportunities, norms, and environment to positively influence change	-	-
6	Self-liberation	Committing to change and believing in the ability to act on it	Emotions	Lacking self-belief in making change
			Management	Lacking the goal of eating healthy
				Absence of call to action or plan
7	Counter conditioning	Substituting unhealthy behaviour with alternative healthy behaviour	Emotions	Overwhelmed by radical changes in a short timeframe
8	Stimulus control	Making changes to replace unhealthy behaviour with that of desired healthy behaviour	Management	Purchasing and preparing healthy food
				Limited time
				Inability to focus on healthy eating post-delivery
				Purchasing and preparing healthy food
9	Helping relationships	Using social support for change in addition to providing care, trust, and acceptance	Management	Neglecting self or prioritising family over self
10	Reinforcement management	Rewarding self for positive behaviour change	Management	Discontinuing or not monitoring progress

Table 6: Processes of diet change and strategies for pregnant women

2. Stages of change

The 5 stages of behaviour change (Weinstein et al., 1998) have been proposed as shown in Figure 15 and they are as follows:

1. Precontemplation: No intention of change in the foreseeable future
2. Contemplation: Being aware of a problem and intending to change in the near future but have not made a commitment to take action yet
3. Preparation: Intention to take action in the near future and reporting small steps towards change
4. Action: Changed behaviour for 1 day to 6 months
5. Maintenance: Changed behaviour for more than 6 months and working to prevent relapse

The processes in Table 6 act as stimuli for creating forward transitions between stages. Although the progression through the above stages is expected to be linear and progressing forwards, there is also a possibility of fallback in the previous stage or relapse onto earlier stages (Velicer et al., 1992). Thus, it is important to evaluate the stage of change throughout the process of change-making.

Each patient has a unique experience and this can be visualised as a journey (Simonse et al., 2019). This means that the duration required for transition between the stages to reach maintenance and avoid relapse varies from one woman to another based on her experiences and surroundings. Additionally, the diagnosis of gestational hypertension can happen any time after Week 20 during pregnancy and so, it is different for each individual. Thus, a generalised training pathway cannot be chalked out. However, as highlighted in the Discover phase, elevated motivation levels should be utilised by promoting the adoption of new, healthy habits. Thus, the ideal goal of the service should be to guide the women to reach the maintenance stage. Additionally, due to the high motivation and care for the foetus, the women are willing to change and so, the transition up to the preparation stage is fast.

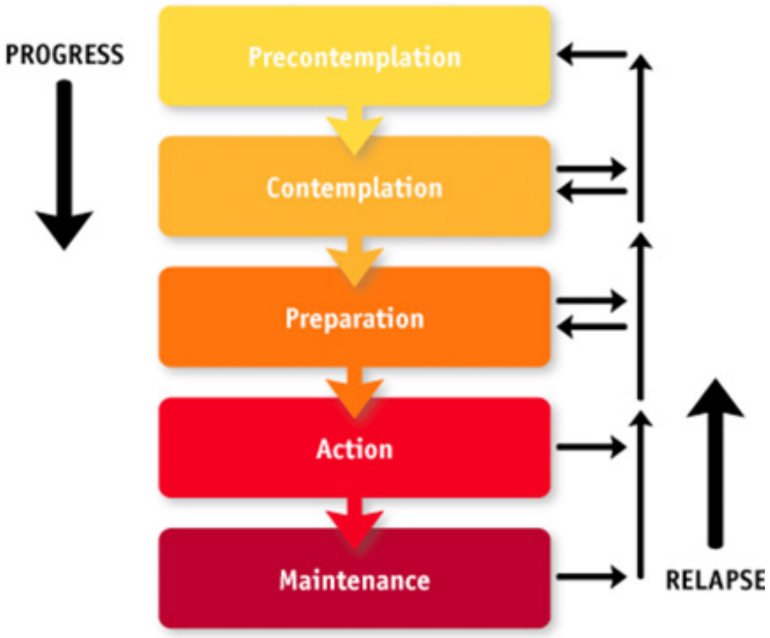


Figure 15: Stages of change (Montazeri, 2013)

To achieve the desired outcome, the right strategy must be implemented at the right time to ensure that the desired action has been taken for the behaviour change to occur. Consciousness raising caters to the barriers associated with knowledge. This process should be implemented at the starting phase of introducing change to help educate the women on the required aspects and to solve their queries. Managing emotions is required through the course of pregnancy and also beyond. Thus, processes catering to barriers under emotions-dramatic relief, self-liberation and counter conditioning, should be implemented through the course of change-making to ensure that diet behaviour change is not affected because of the woman's emotional response. The remaining processes help deal with barriers associated with management and should be implemented throughout, except for environmental re-evaluation. As this is associated with changes in the surroundings, implementing this at the starting phase of introducing change and at the time when the woman is adjusting to her new life with the baby will prove to be useful.

A visual relationship of the three themes of barriers to the stages of change with respect to the available timeframe for change and the desired goal on the stage of change ladder is shown in Figure 16.

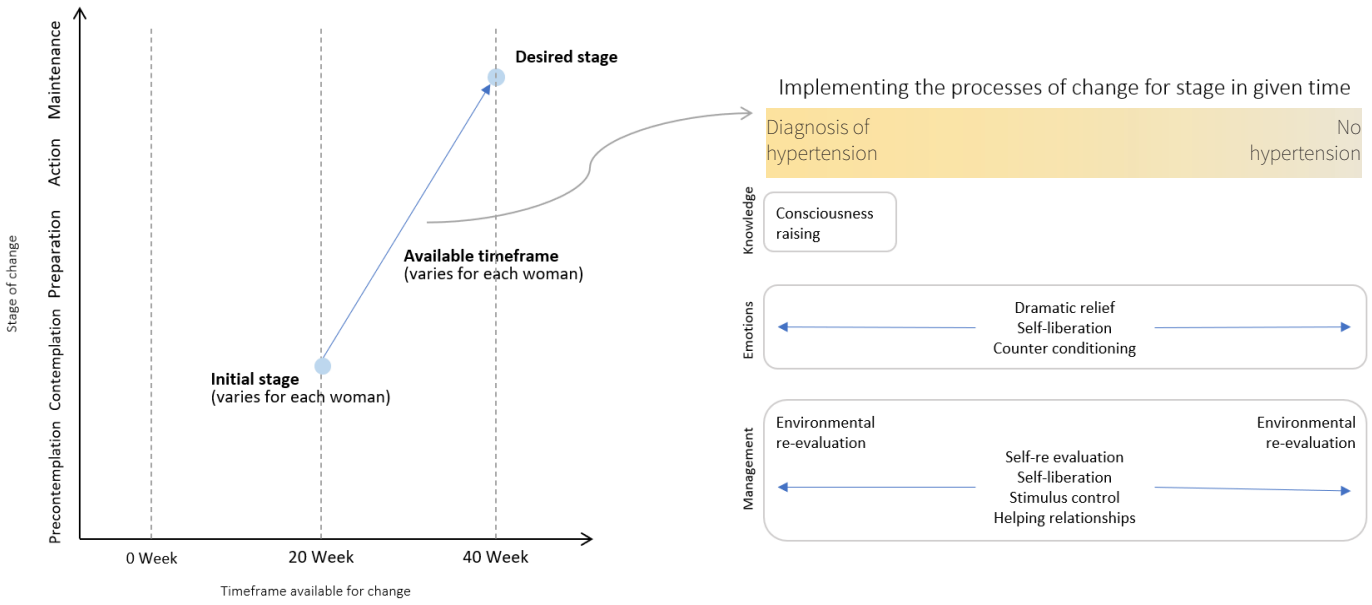


Figure 16: Processes of change in relation to change of stage

Theme	Barriers	Goal from process	Triggers
Knowledge	Absence of knowledge	Increasing knowledge of problems and awareness of behaviour, causes and consequences	Messages delivering information on hypertension and diet change with the goal to provide education and answer questions
	Incorrect information		
	Preconceived notions that are not true		
	Underestimating impact of change		
Emotions	Denial of health condition and emotional impact of diagnosis	Experiencing emotions- initially increased emotional response, then relief on sharing	Prompts to help women open up on what they are thinking and experiencing with the change making process
	Illness evokes emotions of failure and threatens the image of being an ideal parent		
	Stress reduces perceived self-efficacy		
	Stress that is induced due to guilt of failure followed by answerability to family and healthcare team		
	Living in denial of illness and its impact		
	Impulse to eat due to pregnancy cravings		
	Overwhelmed by radical changes in a short timeframe	Substituting unhealthy behaviour with alternative healthy behaviour	Prompts and cues to help focus on smaller timeframe when planning change
	Lacking self-belief in making change	Committing to change and believing in the ability to act on it	Messages to boost confidence and perceived self-efficacy
Management	Inability to focus on healthy eating post-delivery	Understanding impact of behaviour and outcome on others	Messages to help empathise with future self by explaining consequences of unhealthy diet behaviour on self and family in short and long run
	Lacking the motivation to bring about change		
	Intention ends post-pregnancy		
	Failure in following change and lack of tracking actions creates a downward spiral	Assessing change as a part of self-image – with and without change	Regular messages and reminders for tracking diet and adhering to change
	Lacking the goal of eating healthy	Committing to change and believing in the ability to act on it	Messages promoting a gradual change in diet with small actionable steps Reminders to take action
	Absence of call to action or plan		
	Purchasing and preparing healthy food	Making changes to replace unhealthy behaviour with that of desired healthy behaviour	Prompts, reminders and cues that help in re-designing eating habits and home food environment
	Limited time		
	Inability to focus on healthy eating post-delivery		
	Purchasing and preparing healthy food		
	Neglecting self or prioritising family over self	Using social support for change in addition to providing care, trust, and acceptance	Cues to include family in meal planning and planned grocery shopping
	Discontinuing or not monitoring progress	Rewarding self for positive behaviour change	Regular encouraging and motivating messages that inspire women to keep going on the change making journey

Table 7: Tackling diet change in pregnancy using triggers

Key Points:

- The analysis of barriers to diet change reported in the literature identified the needs of the women that they would require guidance on. Thus, the chatbot should be designed to guide the women by (1) helping them cope with emotions, (2) gaining knowledge and (3) assisting them in effectively managing their diet.
- Owing to a varied timeline available for change that is based on the event detection of gestational hypertension in addition to an individual's unique experience, a generalised change pathway cannot be chalked out. However, to utilise the elevated motivation levels during the hypertensive pregnancy, the women are willing to change and so, the transition up to the preparation stage is fast. Thus, to make use of the moment, the ideal goal of the service should be to guide the women to reach the maintenance stage.
- While the service delivers the required support, it is important to evaluate the stage of change throughout the process of change-making. This will ensure the progression towards maintenance and timely detection in case of fallback to old habits.
- As a part of providing training to the women to adopt a healthy diet, the design of the chatbot should make use of triggers in the form of reminders, prompts and cues that apply the strategies from the processes of change to the corresponding barriers identified from the literature. This will ensure that the chatbot provides an immediate personalised response that is useful to the women without requiring the urgent intervention of healthcare professionals.

3.4 DESIGN VISION

The key insights gathered from the research conducted in the Discover and Define phase have been brought together to formulate a design vision that aims to answer the research question that was framed at the start of the design assignment: *How might we design a service that helps women with gestational hypertension to implement the prescribed diet changes by providing personalised support?*

It is envisioned that women with gestational hypertension will be supported using a chatbot-driven service that assists them in effectively managing their diet by providing continuous training based on their lived experiences and with the help of relevant triggers.

Being a situated prototype, the chatbot acts as a data point that provides the required support based on the received response of the women. Thus, the interaction of the women with the chatbot is central to the smooth and effective functioning of the training. Therefore, it is required that the women find the chatbot approachable and the interaction with it seamless so that they feel comfortable in sharing their thoughts and feelings with it. To visualise the experience of interaction of chatbot with the women, a metaphor that encapsulates the feel of it is as follows:

The experience of interacting with the chatbot will be as if the pregnant woman was talking to her close friend.

Elements of the metaphor:

- Confiding feelings with a close friend
- Feeling safe to share all feelings
- Friend helping find a way when needed
- Knowing that a friend is there when needed

Response of the service:

- Empathising with what has been said
- Responding with a "You've got this!" approach

The visuals for the metaphor are as shown in Figure 17. This concludes the first diamond of the design process. The following chapters will look into the design and development of different aspects of the chatbot service.

Figure 17: Visual for metaphor

Chapter 4

DESIGN

This chapter looks into the design of different aspects of the service by bringing together the learnings of the Discover and Define phases and taking the design vision as an inspiration. To guide the design of the chatbot, steps within the service flow were ... and the role of the pregnant women and chatbot was defined with respect to them. This brought forward 5 blocks for the service structure. The learnings so far were applied to each block to achieve the set goals for each.

Goals of the Design Phase:

- Define the steps within the service flow and envision the interaction and role of women and the chatbot for each step
- Formulate the diet challenge
- Outline the blocks of the service structure and define goals for each
- Translate the learnings so far into designing elements that provide training using relevant triggers

4.1 DESIGNING THE FLOW OF THE SERVICE

The flow for the design of the chatbot aims to bring together the key learnings from the chapters before by defining a series of steps that can provide a guide for developing the interaction. For this, the suggested process of providing continuous support in Figure 11 is taken as a starting point. To refine this process, key insights from Chapter 3 have been applied to it and the specific roles of the women and the chatbot have been defined. A visual flow is shown in Figure 18.

1. Understanding diet at start

A clear understanding of the diet at the start of the change-making process is required for the chatbot to make further interactions more relevant. This step lays the base for the design of the support and the training that follows.

2. Providing knowledge

Knowing the influence of unhealthy behaviour on self, on the baby and others can help in avoiding unhealthy behaviour and fasten the pace of behaviour change. For this, the women are provided with key information relating to diet change in pregnancy before suggesting change. Additionally, they are asked to share their concerns and queries.

3. Suggesting goals for change and committing to it

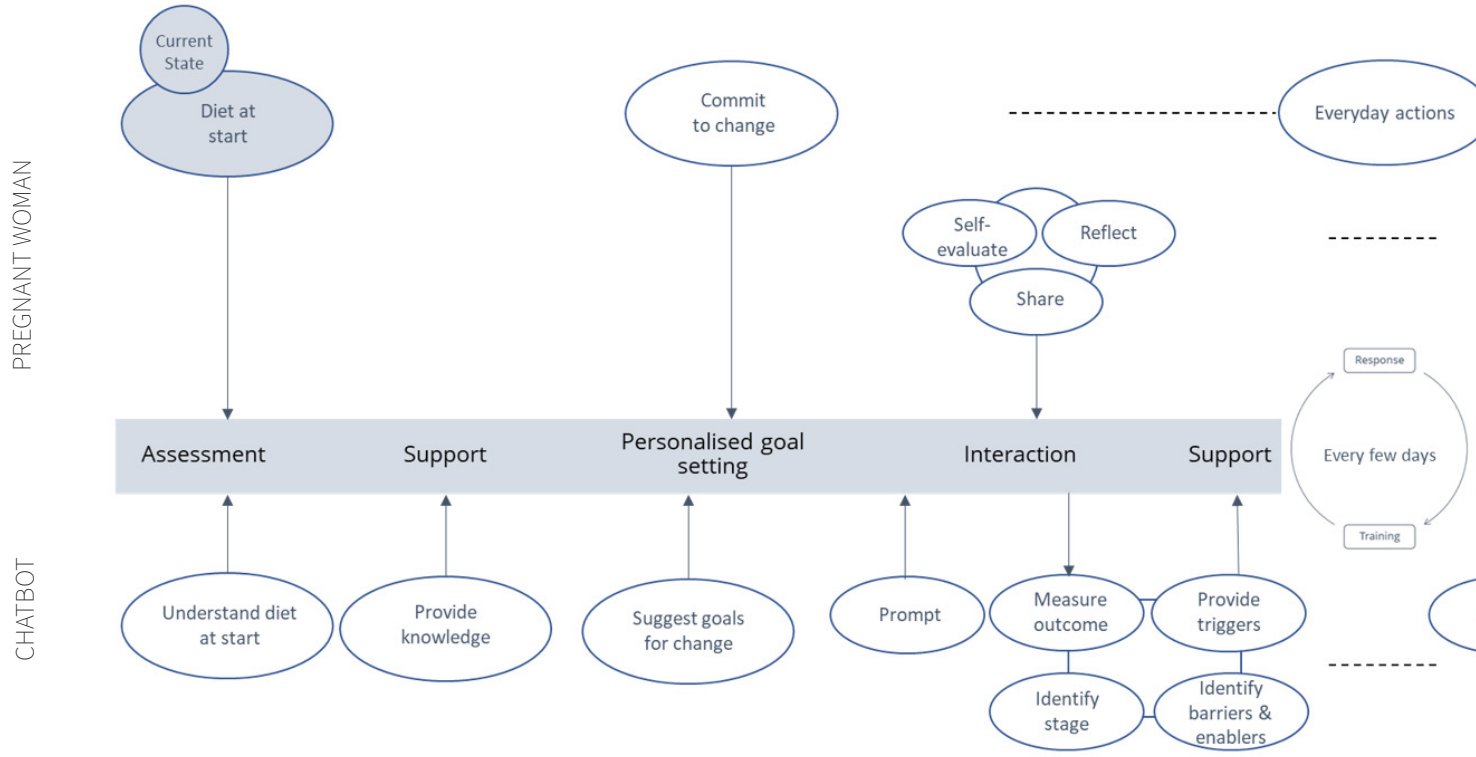
Making drastic changes to diet can be challenging due to the perception of it being an impossible task more so in pregnancy, when the body and mind are going through many changes. Therefore, the approach of breaking down the target behaviour into small goals and translating it into actions that are agreed upon by the woman is applied by the chatbot when designing a path for change.

4. Everyday actions

In the everyday routine and the activities done in it, the woman tries to alter her behaviour with the aim of meeting the goals. Whether the goals are met or not will be evaluated in the following steps.

5. Prompt to measure outcome

The chatbot takes an initiative to send prompts to women asking them to share their progress with goals. This ensures that the contact with the women stays established.



6. Self-evaluating, reflecting and sharing

The outcome of the executing change by performing the planned action can either be success or failure in execution. Either way, providing the woman with a friendly and safe environment to share her thoughts and feelings can help in motivating her for further change or help her in taking constructive action. The chatbot sends messages and prompts to the women on set days aiming to drive self-evaluation and reflection. From the chatbot's perspective, the goal of this contact is to track the progress on the agreed-upon goals and identify factors that facilitated change or acted as barriers.

7. Identifying the stage of change of the woman

As a key part of the assessment, it is important to identify the stage of change of women to adapt to training and prevent fall back onto old habits. This is done by the chatbot by analysing the progress and comparing it with the set goals.

8. Recognizing the barriers or facilitators

Based on the prior knowledge on barriers and facilitators that are fed to the chatbot system, the chatbot compares the responses of the women to identify the underlying factors behind the behaviour.

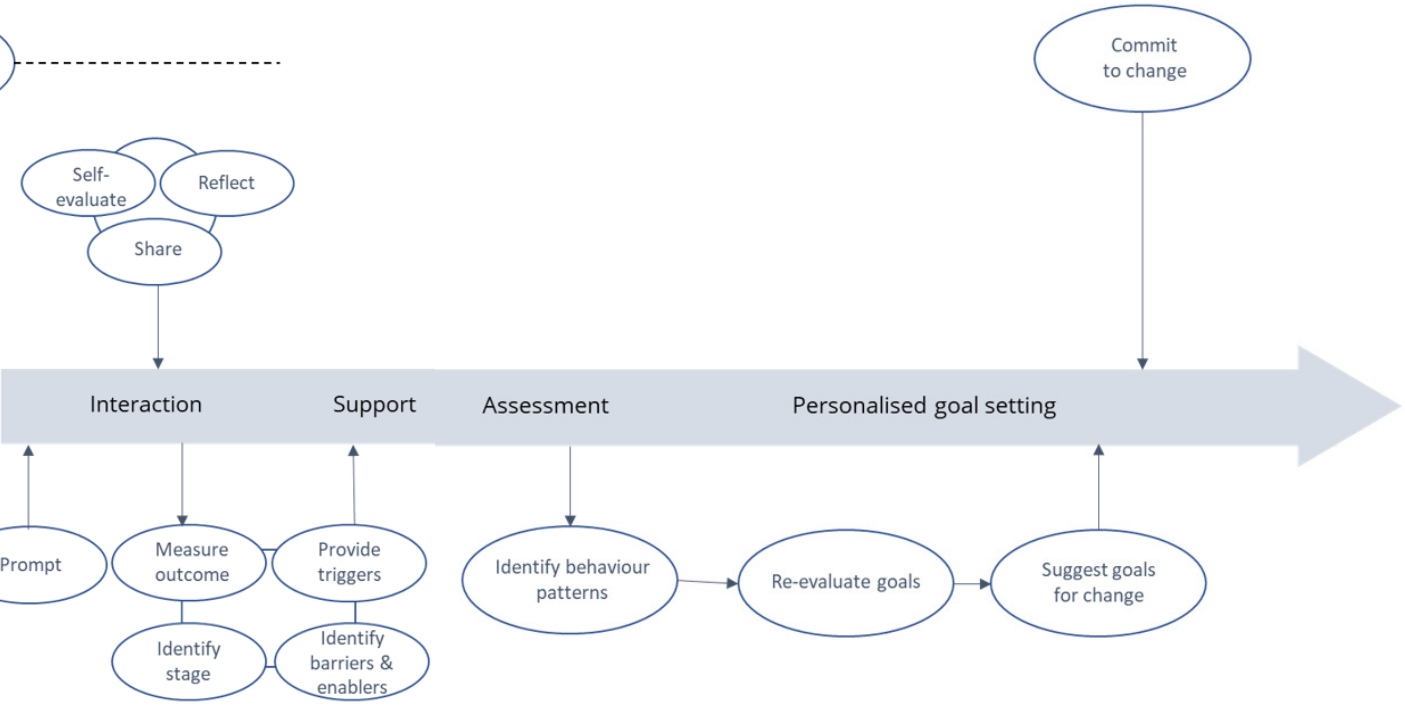


Figure 18: Steps within the service flow

9. Providing suitable triggers

Based on the recognised barriers and facilitators, and comparing them to its pre-fed knowledge, the chatbot makes suggestions in the form of triggers. These triggers take the form of messages, reminders, prompts and cues based on Table 7 and are aimed at driving behaviour change.

10. Re-assessment and re-evaluation of goals

At regular intervals, based on the mapped progress and the stage of change that the woman has achieved, the goals are re-evaluated and triggers providing support are adapted to it.

Beyond this, the entire cycle repeats starting at personalised goal-setting. As the interaction with the chatbot increases, more data points are generated, and the suggestions become more and more personalised as the system gradually adapts to the choices and patterns of the woman. Eventually, as the woman reaches the stage of maintenance, the chatbot prompts to measure behaviour change at time intervals that are placed further away in time as compared to when the behaviour change process was started.

4.2 DESIGNING DIET CHALLENGES

To demonstrate the application of the service flow, a design challenge needs to be designed. For this, the diet requirements in pregnancy were studied from literature and an approach demonstrated in a successful diet change intervention was taken as inspiration.

4.2.1 Understanding diet requirements in pregnancy

Various dietary guidelines have discussed a varied food intake approach to meet the required nutrient and energy requirements of individuals and usually, they take the form of visual representation for easy comprehension like using the Eatwell Guide (Buttriss, 2016) and the Disk of Five approach by the Nutrition Centre (Voedingscentrum). The common element in these approaches is to include the major food elements- carbohydrates, proteins, fats along with fruits & vegetables and liquids in the right proportion.

It is advised to women of child-bearing age to maintain a healthy lifestyle that includes consumption of a variety of foods to maintain a healthy weight and to balance out with appropriate physical activity (Kaiser & Allen, 2008). During pregnancy, women are advised to avoid certain foods like soft cheese, raw eggs, unpasteurised milk, and unprocessed or undercooked meat that pose the risk of harmful bacteria (Williamson, 2006). The energy requirements of pregnant women within the healthy weight range are the same as that of non-pregnant women up to the second trimester. For women carrying a single foetus, the energy

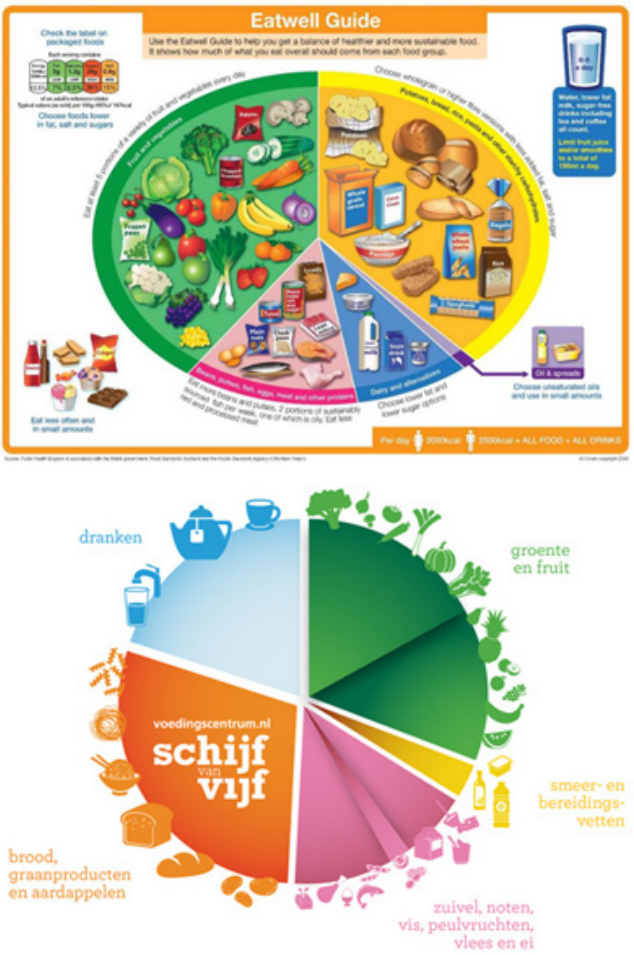


Figure 19: Visual representation of general diet requirementst (Buttriss, 2016; Voedingscentrum)

requirements increase by 340kcal on average in the third trimester. The dietary advice for hypertensive pregnant women remains the same as that of women with normal pregnancies. In addition to this, they may be advised to take additional nutrient supplementation (Procter & Campbell, 2014).

Various studies that have implemented diet change during pregnancy using different forms of interventions have applied the above knowledge of diet requirements in pregnancy. One such successful study conducted research to investigate the effectiveness of counselling provided for women with excessive weight gain during pregnancy (Abdel-Aziz et al., 2018). The parameters relating to diet change monitoring were as follows:

A food-frequency questionnaire was used to gather insights on the consumption of fast foods and snacks, the frequency of skipping meals and vitamin intake. The frequency structure was divided into the following categories: rarely, 1–2 per month, once a week, 2–3 times a week, and daily. The daily items included energy-rich foods primarily consisting of carbohydrates like bread, rice, pasta, and cereal and dairy with a consumption frequency of one or more times a day. The other categories included proteins from animal or plant sources, fats, unhealthy snacks, and sugary items. In addition to this, the frequency was noted for the consumption of fried or fast food or unhealthy snacks and meal skipping.

4.2.2 Formulating diet change challenges

Taking inspiration from the study setup mentioned above and a basic understanding of diet requirements in pregnancy, the metrics In Table 8 is formulated with the aim to make the food consumption measurable. Five aspects relating to the diet have been identified- rice, pasta and bread, snacks, fruits, vegetables, and finally sugary/processed drinks. Each of these has corresponding categories that measure the quantities and types of items consumed.

Literature has identified that aiming to make up to 3 changes in diet habits over 2 weeks proves to be an effective goal. The women may need to modify more than 3 aspects of their diet. So, to recommend 3 changes as a starting point, food items are prioritised in the order- sugary/processed drinks followed by snacks then bread, pasta and rice, after those vegetables and finally fruits. The order is such that sugary/processed drinks are recommended first as items to change. As the change in diet needs to be in small steps, the specific change is proposed by suggesting the next healthiest alternative on the table. For example, if the chosen category for fruits is 3, then the suggestion would be category 2. In this manner, up to 3 changes are identified and presented as challenges for the coming two weeks.

	Category 1	*Category 2*	*Category 3*	*Category 4*
Bread, pasta, rice	Wholemeal or brown almost always	Sometimes wholemeal or brown	Almost never wholemeal or brown	-
Snacks	Fruits, cucumber, peanut butter, or crackers	... but also, cookies, candies, or cake	Almost always cookies, candies, or cake	-
Fruits	1-2 a day	1-2 every other day	Sometimes, if I feel like it	I almost never eat a fruit
Vegetables	200 grams or more	About 100-200 grams	About 50-100 grams	Less or almost never eat them
Sugary/processed drinks	Sometimes	200 ml	Between 200 and 500 ml	500 ml or more

Table 8: Proposed diet change chart

4.3 SERVICE STRUCTURE

Defining a structure to the service that is based on the flow is beneficial in guiding the process of development. The overall structure of the service is as shown in Figure 20. It consists of 5 modules- getting started, understanding hypertension and diet, diet change, training, and managing emotions. These are further divided into functions. Though identified as separate groups, the modules and functions within may have an overlap as they are interdependent.

Of the 5 modules, the first three- getting started, understanding hypertension and diet, and diet change, are primarily executed once at the start, that is on Day 1 of using the service. Specific functions within it, like the function of clarifying doubts, could be used by the chatbot later in case it is required. Overall, the goal of these 3 modules is to serve as a starting point where the woman learns more about the service, provides personal information on aspects that is crucial for training and undergoes a diet evaluation.

Following this, the other two modules- training and managing emotions are executed as a part of the remaining service flow. They aim to apply the triggers identified in Chapter 3.3. While managing emotions is a part of the training module, it is separated for simplifying the service structure. The following sections will explain each module and the functions that are described within it.

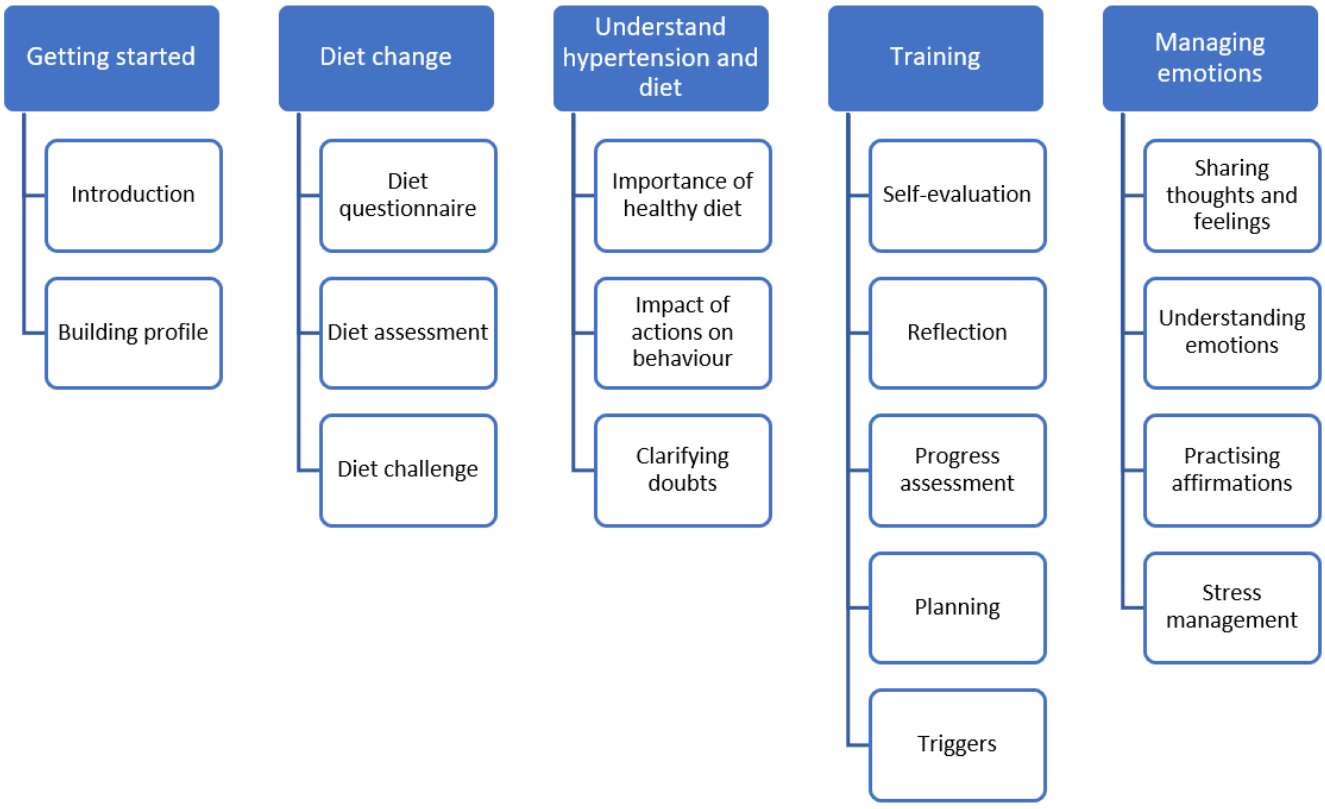


Figure 20: Overview of service structure

4.3.1 Getting started

The goal of this module is to introduce the chatbot to the woman and to gather basic information about the woman that will help in getting started.

1. Introduction

This serves as the first module that introduces the chatbot to the woman. It sets an informal tone of communication and makes the woman feel comfortable in sharing her thoughts.

2. Building profile

As the system behind the chatbot is constantly learning and adapting, it needs to know who it is interacting with and a few details on the background of the woman. For this, it collects information on the number of people and kids in the household, work status, pregnancy week, history with pregnancy-related medical conditions and weight and height.

4.3.2 Diet change

The goal of this module is to identify points of improvement within the diet of the women and suggest changes in the form of challenges that they can take.

1. Diet questionnaire

This section is based on the proposed diet change chart in Table [Fix Me]. The woman is taken through a series of questions where she is required to pick the category that suits best to her current diet.

2. Diet assessment

Based on the answers provided in the diet questionnaire, the existing diet of the woman is compared to the Table [Fix Me] for identifying 3 changes.

3. Diet challenge

The diet challenge is formulated and presented to the women based on identified changes in the diet assessment function. This challenge lasts for 2 weeks. As a response, the woman is asked to confirm if she agrees to the challenge and if she thinks she can make the required changes. Following this, the woman confirms the start of monitoring.

4.3.3 Understand hypertension & diet

The goal of this module is to provide information to the woman on aspects relating to the hypertensive disorder of pregnancy and the impact diet has on it in the short and long run. It also aims to address the queries of women.

1. Importance of healthy diet

This function explains the significance of consuming a healthy meal. It stresses the fact that the change in diet needs to be sustained in the long run.

2. Impact of actions on behaviour

This function presents the negative impact of unhealthy eating and not following the given recommendations on the health of the woman. This function is called before diet recommendations are suggested. The additional importance laid by this function provides for setting up the stage to accept change by the woman. Additionally, this function could also be called by the chatbot on a later day in case of non-adherence to diet is observed.

3. Clarifying doubts

Here, the concerns in the mind of the woman are addressed. She is given a chance for asking questions relating to diet and hypertension. The chatbot then provides a responds immediately or after consulting with the medical specialists, if required. In case the woman has doubts on a later day, she can prompt for asking a question and this function gets called.

4.3.4 Training

The goal of this module is two way- it serves to train the chatbot system based on the woman's responses while also training the women to adopt and integrate changes in their everyday routine.

1. Self-evaluation

Initially, the woman is sent prompts at a fixed time every 3 days where she is prompted to share the progress on the diet challenges. The process of self-evaluation puts the woman through a series of questions that take her through each of the three challenges one after the other. This function primarily addresses the question, "Was the diet followed?" Over time, as the woman approaches maintenance, the time interval between prompts is increased.

2. Reflection

Following self-evaluation, this function dives deeper into the process of self-evaluation and aims to answer, "What factors helped? What came in the way of change?" It prompts the woman to think of the possible reasons why she could or could not bring about the required change.

3. Progress assessment

This function is executed as a part of the back-end processing. The function of diet assessment under module diet change is a sub-function to progress assessment. After every self-evaluation and reflection, the stage of change achieved by the woman is measured as compared to her previous progress. This is compared to the available timeframe that is still left for delivery.

4. Planning

This function is executed as a part of the back-end processing. Taking forward from progress assessment and using inputs from self-evaluation and reflection, this function formulates the next plan of action to train the woman in incorporating healthy eating as a part of the routine and effectively managing diet change.

5. Triggers

This function sends triggers identified from Table [Fix Me] to the woman to ensure that she stays on track with the change-making process. These serve different purposes like acting as reminders, cues or prompts to drive the change-making process. For example, it includes sending reminders for planning groceries and meals in advance. It also includes prompts at specific times of the day to remind them of not eating a specific unhealthy food that they are habituated to or prompts to remind them of eating something that they are not used to. Eventually, as data collection increases, the system could also be programmed to act in real-time without requiring the written input from women. Instead, the chatbot system could be connected to various sensor inputs to gather data on pulse levels, sugar levels, sleep, exercise etc. that act as influencing factors to the everyday diet.

4.3.5 Managing emotions

The goal of this module is to cater to the emotions of the emotional response of the woman that may be affecting the change-making process. This is a part of the training process. However, to bring clarity in service structure, the aspects relating to emotional response are separated from the general activities that come under everyday management.

1. Sharing thoughts and feelings

This function provides the woman with prompts to help her speak out about what is on her mind. With this, the chatbot aims to identify if the emotional state of the woman is affecting the diet change process. Additionally, the woman gets a sense of relief having poured her heart out.

2. Understanding emotions

This function is executed as a part of the back-end processing. Taking the messages on thoughts and feelings as inputs, this function enables the chatbot to understand the emotional response of the woman. The chatbot uses this to identify triggers that could be provided to help the women deal with the emotions.

3. Triggers for affirmations

This function aims to build back motivation and self-belief by sending messages and prompts that drive positive emotions in the woman's mind. For example, on identifying, low self-belief, the chatbot shared quotes to keep up the spirits.

4. Stress management

Pregnancy is a time when the woman experiences many emotions that are oftentimes driven by hormones. Hypertensive disorder of pregnancy further adds to the emotional response by bringing in additional stress. This function aims to ensure that stress levels are kept in control. This is done by activating the function if the sentiment of the messages is sensed to be negative for interactions on multiple days in a row. Additionally, as stress levels are directly linked to unhealthy eating, the function is called in case an association is found between negative emotions and unhealthy food consumption. As a response, the chatbot makes suggestions for managing stress levels through different ways like meditation, music, or going on walks.

4.4 CREATING A HUMAN-LIKE INTERACTION

When implementing the service structure for the chatbot, it is necessary to achieve a human-like interaction to ensure that the chat flow feels natural. For this, the following 18-step guideline is suggested when designing for Human-AI interaction (Amershi et al., 2019). Integrating this guideline with the metaphor for interaction defined in Chapter 3, the chat flow and message tone of the interaction was designed.

To develop a feeling for talking with a person, it was decided to name the chatbot. Thus, a conversational agent, Zoe, was created as a virtual face behind the chatbot. The qualities identified in the metaphor were integrated when building its responses and executing the different modules and functions under the service structure.

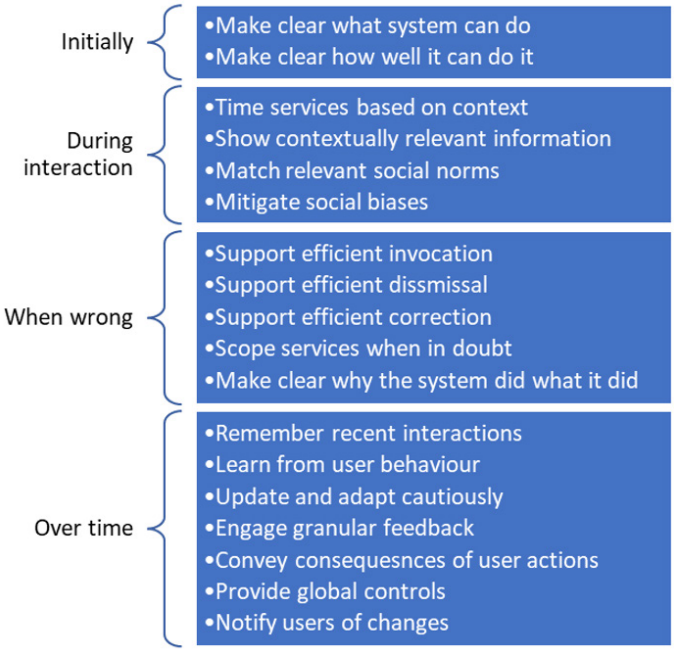


Figure 21: Human-AI interaction design guidelines

Key Points:

- The service structure brings together the learnings from the first diamond and demonstrates the application of triggers identified in Chapter 3.3 for providing knowledge, coping with emotions and effectively manage their diet with the help of modules understand, managing emotions and training respectively.
- A conversational agent, Zoe, was created as a virtual face behind the chatbot. The interaction qualities defined for the metaphor in Chapter 3 were integrated with the guidelines for human-AI interaction for providing a human-like experience when using the chatbot.

Chapter 5

DEVELOP

In order to test the potential a chatbot-driven service has on technical feasibility, functionality and viability of development when using it as a tool to provide training and support to women, a prototype was developed using the Telegram app. This chapter sheds light on the approach followed for prototyping and displays screenshots of the chatbot app to show the achieved results.

Goals of the Develop Phase:

- Define the scope for the current stage of prototype development
- Focus on achieving a human-like interaction
- Integrate features for ease of interaction

5.1 DEFINING THE SCOPE FOR THE PROTOTYPE

Chapter 4 explores the design aspects of the overall chatbot, its interaction with the women and the back-end system in detail. This is taken forward in the development of the chatbot to demonstrate the technical feasibility, functionality and viability of the proposed solution. However, implementing all of it in the available timeframe is not possible. Therefore, it is important to define a scope for the development.

The training module in the service structure is a central factor of the chatbot structure and implementing it will help demonstrate the fulfilment of the set goals. However, to provide a starting point to the chatbot and define a flow to the following interaction, the development of getting started and diet change modules is required. Thus, it is concluded to proceed with the development of the 3 modules- getting started, diet change and training as shown in Figure 22.

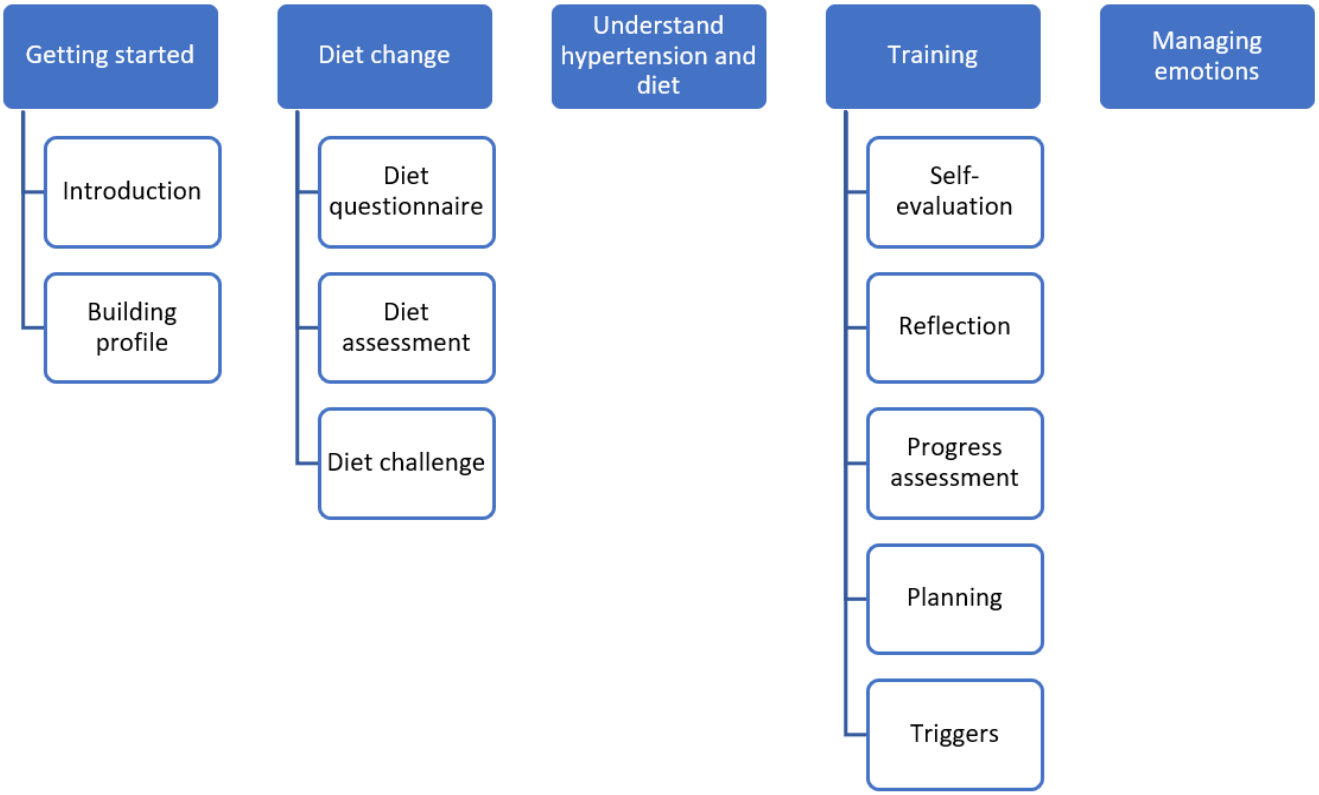


Figure 22: Overview of implemented service structure

5.2 CHATBOT PROTOTYPING

Telegram was used to develop the chatbot. The reason for choosing Telegram was to provide a secure communication channel. The chatbot was built using Telegram API. The program for which was written in Python with the help of the python-telegram-bot library.

To maintain privacy, unique chat-ids were generated by Telegram. This ensured that the program made use of only the chat-ids instead of associating personal details of participants like name, phone number, email id. This also facilitated the ease of code as the bot could have personalised and simultaneous conversations with participants based on their unique chat ids and message ids.

The cloud service by AWS was used. This ensured that the bot remains online for communication without the need for a dedicated PC or laptop. Other advantages for using AWS were very low delays in communication and avoidance of unexpected failure of the program due to power outages. The user chats were collected in a csv file which was also stored on the AWS server. Over a period of time, the collected data can be deployed to train the chatbot's NLP and the response system.

Additionally, the prototyped system was developed to hold simultaneous conversations with women. The visualization of the prototyped system can be seen in Figure 23.

The following images show parts of the interaction that were prototyped.

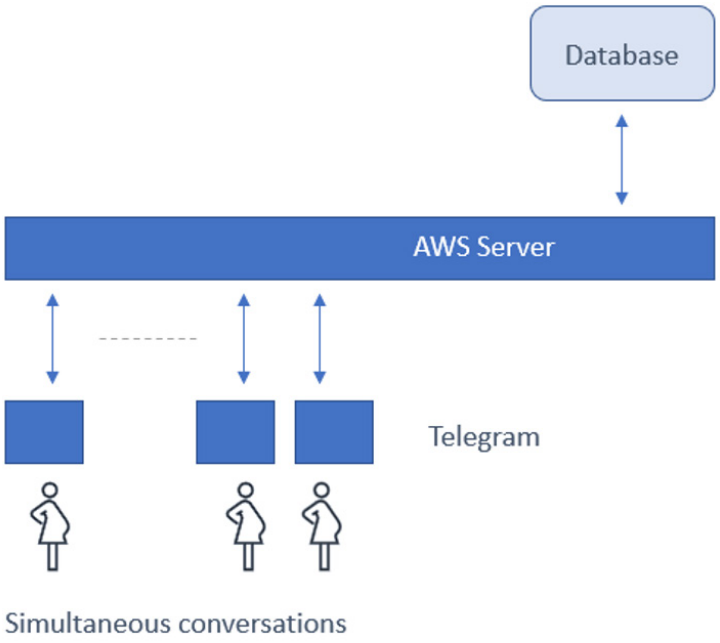
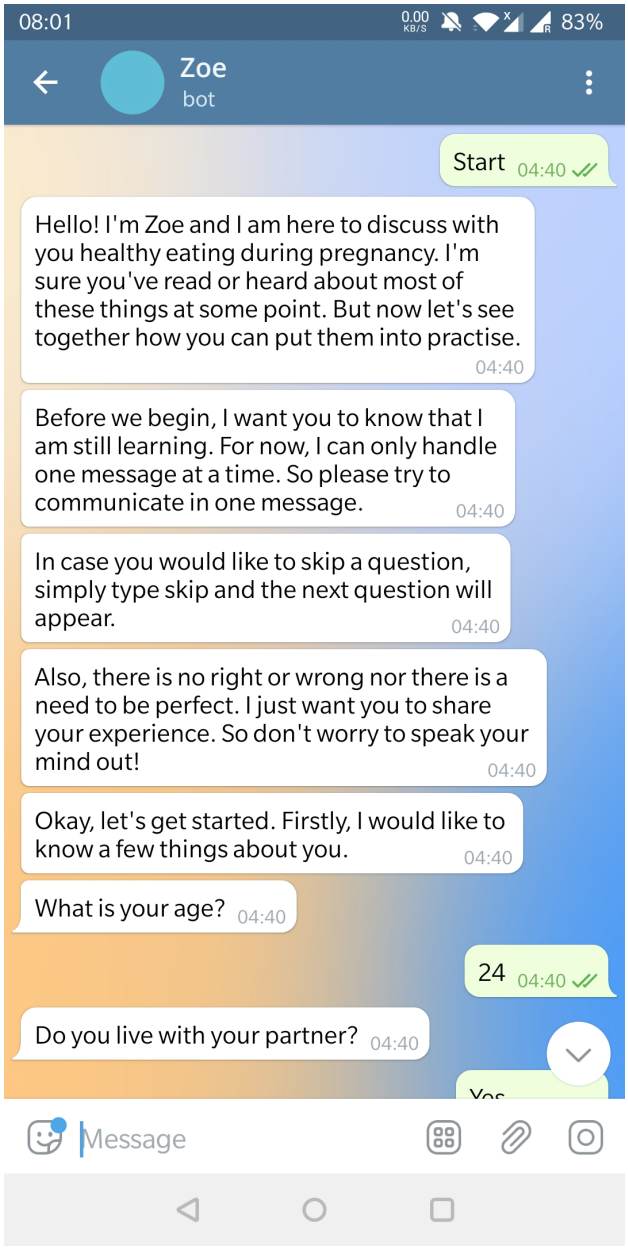


Figure 23: Visualization of prototyped system

Module- Getting Started



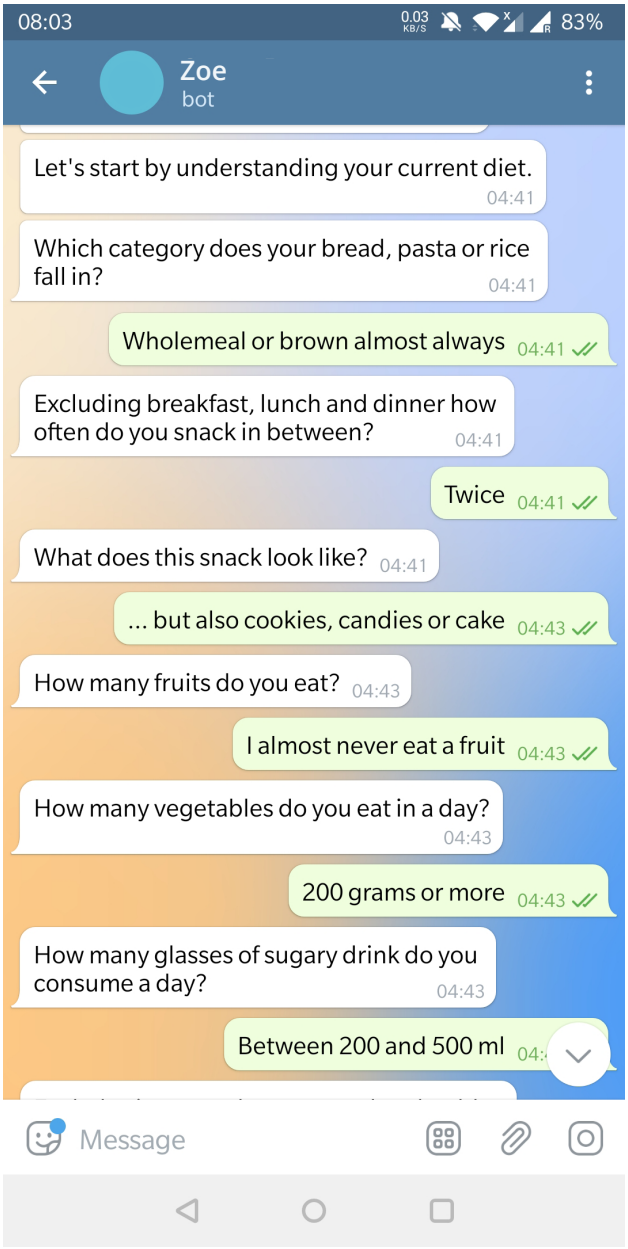
Function- Introduction

- Introducing the chatbot
- Setting up for the conversations

Function- Building profile

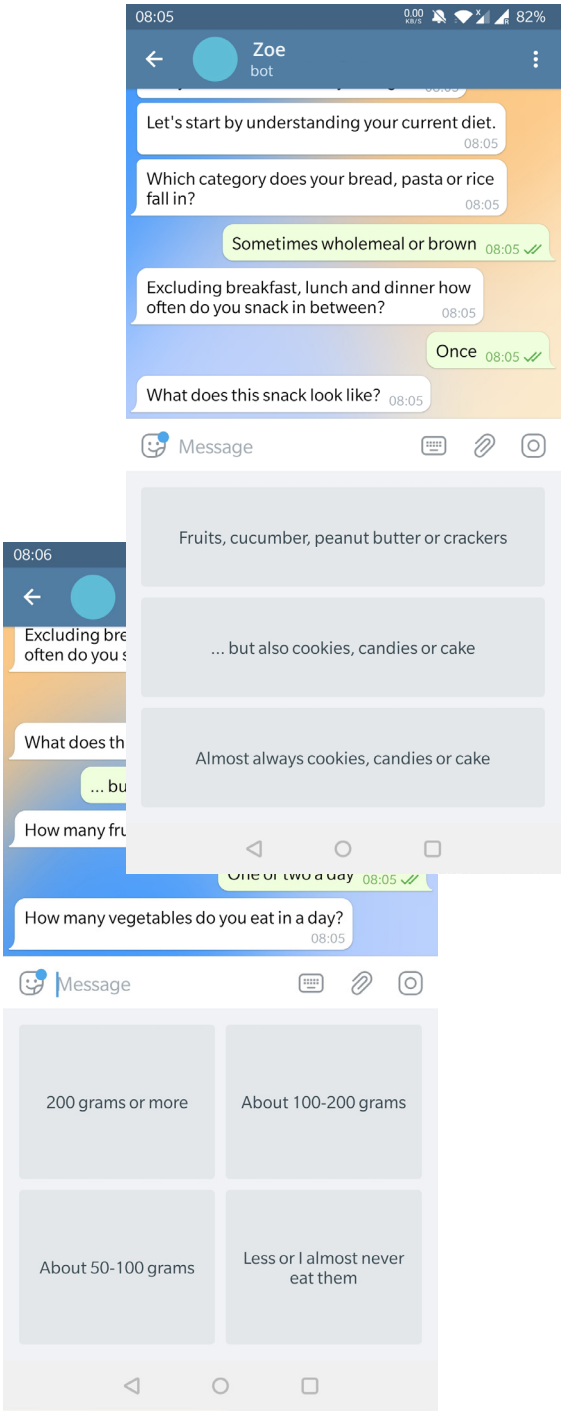
- Asking questions about the woman and pregnancy

Module- Diet Change



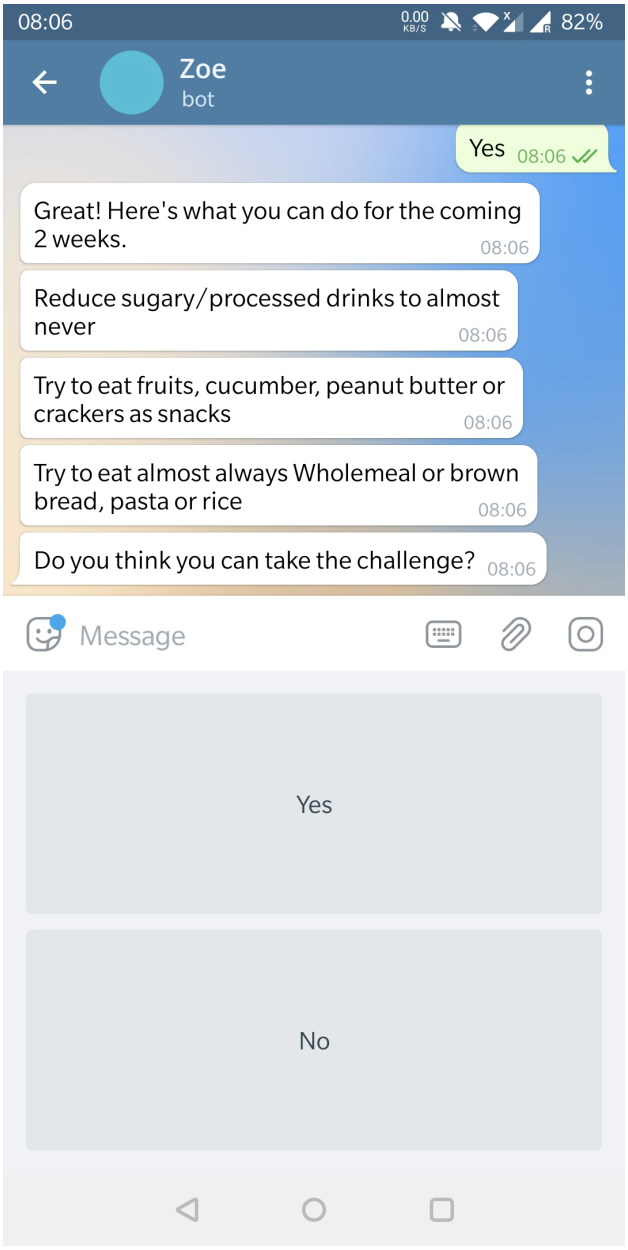
Function- Diet Questionnaire

- Questions based on the diet change chart



- Providing custom keyboard for questions for ease of use

Module- Diet Change

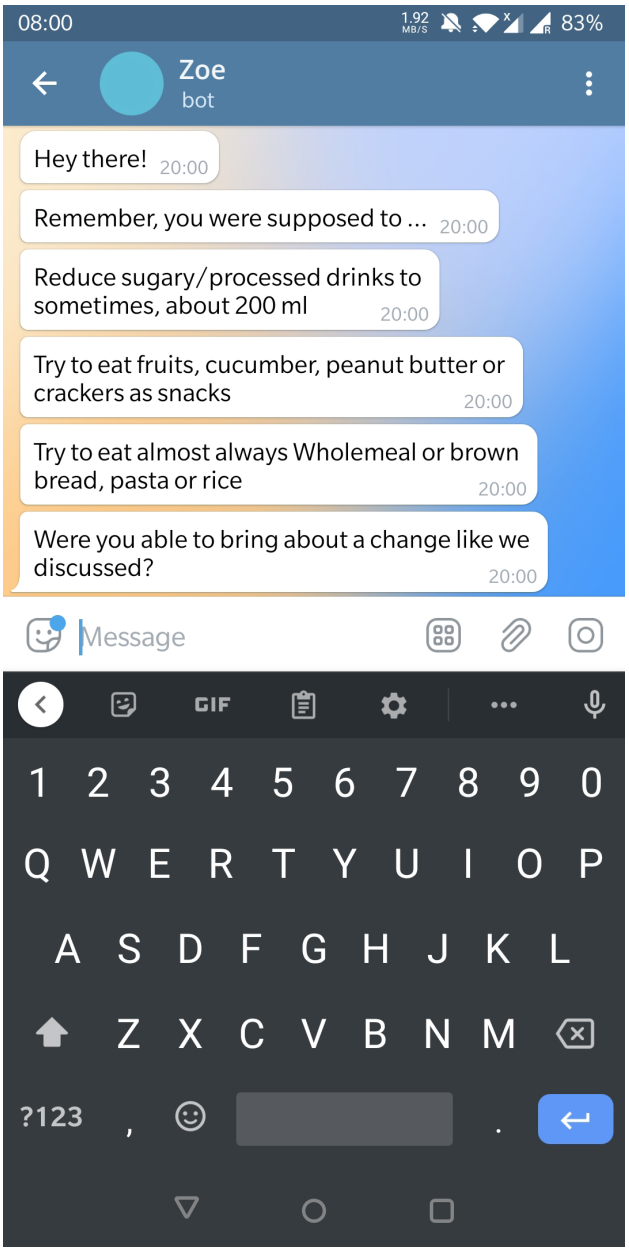


Ending on a motivational note

Function- Diet Challenge

- Setting up upto 3 challenges for the coming 2 weeks based on diet questionnaire

Module- Training



- Understanding change making from the woman's perspective

Chapter 6

CONCLUSION

The goal of this study was to answer the research question: *How might we design a service that helps women with gestational hypertension to implement the prescribed diet changes by providing personalised support?* Within this thesis, a solution has been proposed to implement a chatbot-driven service that assists the women in effectively managing their diet by providing continuous training based on their lived experiences and with the help of relevant triggers. Thus, it improves the current care pathway by providing (1) immediate response without increasing the load on the medical team, (2) ease of interaction through uninterrupted contact and increased reach and (3) personalization of care utilizing tailored support.

A continuous care approach has the potential to fill in the support gaps between appointments by guiding the women at regular intervals and helping them to integrate diet change into their routine. A chatbot for smartphones offers an affordable, portable, and convenient mode for communication. The introduction of the chatbot at the key teachable moment of hypertensive pregnancy- the diagnosis of hypertension, can facilitate healthy diet adoption in the pregnancy period and beyond. Reinforcing the diet advice at the contact points with the healthcare professionals and evaluating the diet goals and progress will thus, improve the overall care pathway with the same or fewer contact points with the healthcare team.

The developed chatbot deploys a training-response cycle that makes use of the barriers and enablers reported in the literature as a starting point to suggest relevant triggers. It is envisioned that with more data points, the guidance provided to the women can be better tailored.

The chatbot was developed with the aim to conduct a situated pilot study within the project period to demonstrate the personalized approach that the chatbot has the potential to deliver and get user feedback. However, due to the limitations in timeframe and the limitations due to Covid-19, it was not possible to get in touch with pregnant women and collect data from them in real-time. Therefore, further analysis through user testing is recommended to understand its acceptability and desirability in everyday use.

The following sections will evaluate the chatbot using the DVF framework and provide recommendations for future implementation.

6.1 RECOMMENDATIONS

In order to deliver immediate personalised responses to women, the chatbot needs to generate a database that stores responses and multiple situations from the everyday lives of such women. In the current development stage, the setup with the database has been designed. By deploying the chatbot as a tool to collect data, it is possible to generate a training set that can be used for machine learning algorithms. This will help to improve the chat flow, the responses of the chatbot and the tone of voice used during the interaction. In the later stages, there is also a possibility of integrating sensor data like that of pulse rate, glucose readings, sleep duration from the woman. This will aid in monitoring the response of the woman's body and make the provided support more relevant for the woman and also provide the healthcare professionals with detailed insights.

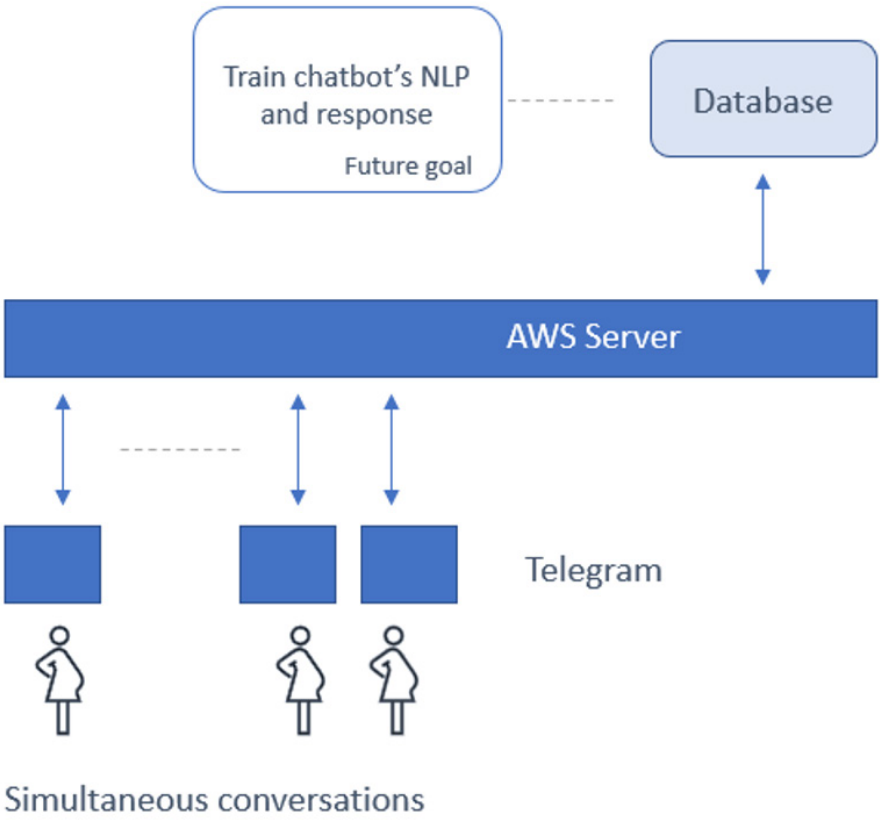


Figure 23: Visualization of prototyped system

6.2 EVALUATING THE CHATBOT

To evaluate the developed solution, it has been analysed from desirability, viability, and feasibility perspective. The DVF framework is popular within the Design Thinking approach. It attempts to create a balance between what is desirable for the users, what is feasible to be made using technology and what is viable economically. A few questions that are relevant to the design and development of the chatbot have been formulated for each of the three and the final delivered prototype of the chatbot has been evaluated.

Desirability:

Does it address a pregnant woman's needs?

Does it appeal to the women, and would they want to use it?

The chatbot has been designed to make use of the challenges faced by the woman and provide them with the required support as and when they need it. As it gets to know more about the patterns of behaviour from the responses of the women, it gets better at providing support. Thus, the proposed solution does have the potential to address the needs of women. However, as it has not been tested with the women. Therefore, it is difficult to comment on whether it would appeal to them and if they would like to regularly use it in the long-term as an interactive tool to help them with diet change.

Viability:

Does it reduce the cost of care?

Does it reduce the stress on the healthcare system?

The proposed solution has a positive impact on both, the cost of care and the stress on the healthcare system. As the intervention has been designed for automation, it is not dependant on a person to send out a response. Additionally, it does not require a dedicated person to contact the women regularly and get feedback as in the case of mHealth interventions that make use of telephones or emails. The cost of development is one time.

Feasibility:

Is there easy access to the implemented technology?

Does the technology have the capability required to make it?

As the chatbot is built using the Telegram app, it can easily be installed on any phone, thus making it easily accessible to a wide population. Additionally, given the potential of smartphone interventions to cater to a large population, the focus can still be kept on individual needs due to one-on-one contact. In order to run effectively, the chatbot requires data from the woman. Then, with the help of machine learning, it is possible to improve its working capability further. At the current stage of development, this is not possible. Thus, the technology relies on the available data for optimum use.

All in all, it can be concluded that the developed prototype of the chatbot aids in improving the current care pathway. This means that it has the potential to assist women with gestational hypertension in effectively managing their diet.

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APPENDIX 1

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Khot
initials: R.U. given name: Rucha
student number: 5028604
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):

IDE master(s): ★ IPD ☐ DfI ☐ SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ☐ Honours Programme Master
specialisation / annotation: ★ Medisign
☐ Tech. in Sustainable Design
☐ Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Kleinsmann, M.S. dept. / section: DOS/MOD
** mentor: Kim, K.H. dept. / section: DOS/MOD
2nd mentor: Bais, B.
organisation: Erasmus MC
city: Rotterdam country: Netherlands

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

comments (optional): Despite being from the same section- MOD, the chair and mentor have a different focus that collectively supports the project brief i.e. Ki-Hun Kim: Data mining; Maaike Kleinsmann: Strategic Design, Smart Technologies

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair _____ date 13 - 04 - 2021 signature _____

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC

List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed

NO missing 1st year master courses are:

name _____ date - - signature _____

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name _____ date - - signature _____

Initials & Name R.U. Khot Student number 5028604

Title of Project A product-service intervention for hypertensive pregnant women

A product-service intervention for hypertensive pregnant women project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 02 - 03 - 2021 04 - 07 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

This graduation project is a part of "my digital twin" flagship project that involves researchers from TU Delft and Erasmus MC. The goal of the flagship is to design for preventive care using the Digital Twin technology. A digital twin is the collection of digital data that represents a virtual replica of a physical object or person. This graduation project specifically addresses the smart pregnancy aspect that aims to collect, analyze, and utilize data from a hypertensive pregnant woman when designing for her personalized care.

Hypertension, widely referred to as high blood pressure, is a medical condition in which the blood pressure is elevated to high levels. While hypertension is a worldwide health problem, it is also the most commonly found disorder during pregnancy that affects around 10% of all pregnant women. High blood pressure is a substantial cause of complications in pregnancy, maternal morbidity and still births. Women with hypertensive disorders in pregnancy are also at increased risk of cardiovascular disease in the future. There are various stages or forms of hypertensive disorder- women with hypertension from before pregnancy or diagnosed with it in the first 20 weeks (chronic hypertension), detection of hypertension after the first 20 weeks (gestational hypertension) and hypertension involving multiple organs (pre-eclampsia and eclampsia).

With early detection of hypertension, it is possible for women to have a normal pregnancy with mild to moderate hypertension. However, this requires making certain lifestyle changes. A major aspect of lifestyle modification for hypertensive pregnant women focuses on diet change. This involves eating a healthy balanced meal with less salt and high in protein. Research on food consumption patterns in pregnant women has shown that around 12% of pregnant women consume food from takeaway more than twice a week. Convenience foods, that include takeaways and processed foods, contain additional amounts of salt, sugar, and fat to extend their shelf-life and make their flavor more appealing. Consuming such foods frequently can therefore elevate health problems in hypertensive pregnant women.

During pregnancy, bringing about changes in the diet can be challenging and stressful, particularly if the woman is habituated to it for a long time. Thus, there is a need to understand the perspective of a pregnant women when she is bringing about a diet change to understand the underlying challenges. This can serve as a key input when designing a service that helps in bringing about a lifestyle change in women.

space available for images / figures on next page

introduction (continued): space for images

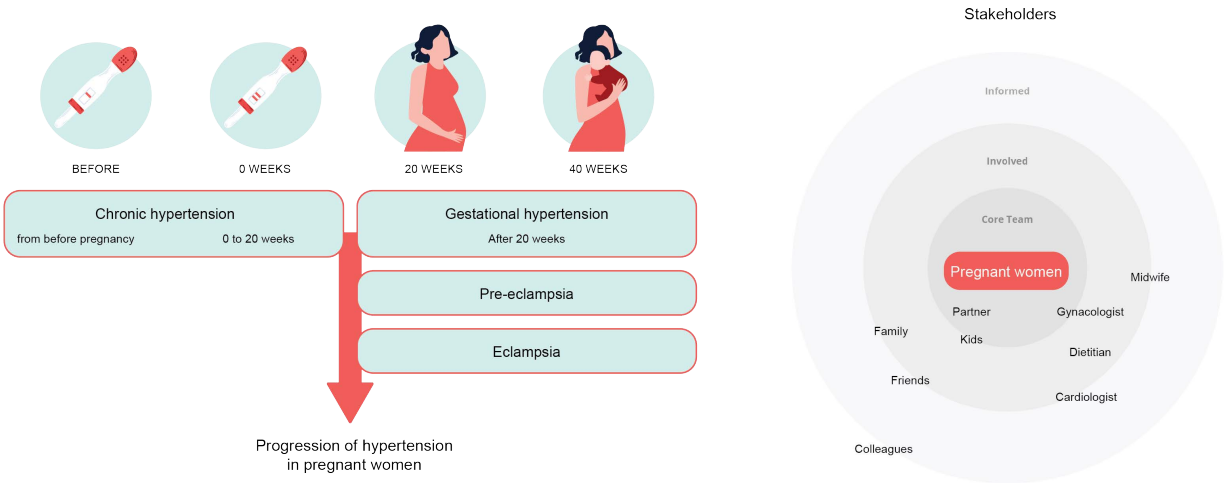

image / figure 1: Hypertension in pregnancy and stakeholders

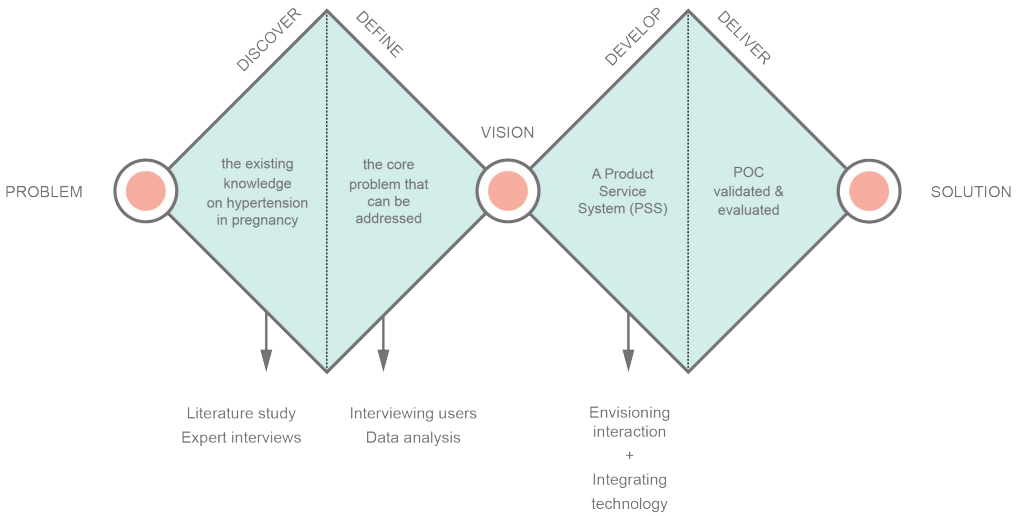

image / figure 2: Design process

Initials & Name R.U. Khot Student number 5028604

Title of Project A product-service intervention for hypertensive pregnant women

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The scope of this study is to answer the research question, how can smart digital technologies support and motivate women diagnosed with high blood pressure in pregnancy -who consume convenience food- to eat healthy alternatives that fit the prescribed diet recommendations?

The final goal is to develop a product-service intervention that can motivate hypertensive pregnant women to avoid convenience food. The findings from this study can later be utilized in the development of a digital twin intervention designed for smart pregnancy.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The focus of the project is to identify the drivers of convenience food consumption for hypertensive pregnant women and the factors that deter them from following the prescribed diet recommendations. The design solution is envisioned as a product-service intervention that refrains hypertensive pregnant women from consuming convenience foods.

Data collection:
Takeaway and online food ordering logs from apps and/or websites used by the participant will be collected prior to the interview. An online interview of maximum 1 hour will be conducted to identify variables that influence the consumption of convenience food by pregnant women. The format of the interview will be semi-structured to help the participants express their thoughts freely while still allowing to stay relevant to the topic.

Data analysis:
Qualitative analysis will be the primary technique for analyzing the gathered data. Themes relating to convenience food consumption and intervention points on a user journey will be identified. Data analysis will conclude at formulation of a vision for service intervention.

Development and testing of Product-Service intervention:
A service intervention prototype with the aim to motivate pregnant women to bring about a dietary lifestyle change will be designed such that it addresses the findings in data analysis. This intervention will be tested on a small group of 3 to 5 pregnant women within the study population with the goal to validate the hypothesis.

Initials & Name R.U. Khot Student number 5028604

Title of Project A product-service intervention for hypertensive pregnant women

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 2 - 3 - 2021 4 - 7 - 2021 end date

Month	March					April				May				June					July				August
Calender week	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Date at start of week	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2
Project week	1	2	3	4	5	6	7	8	9	10	11	12	13	-	14	15	16	17	18	19	20	21	22
Working days in the week	4	5	5	5	4	4	5	5	4	4	3	5	4	-	5	5	5	5	5	5	5	5	3
Project day at end of week	4	9	14	19	23	27	32	37	41	45	48	53	57	-	62	67	72	77	82	87	92	97	100
Phase / Activity																							
Discover																							
Literature study																							
Interview material development																							
Ethics committee application																							
Interview with expert																							
Define																							
Interview with user																							
Analysis of data																							
Identifying themes																							
Ideation for PSS																							
Develop																							
PSS development																							
Testing & validating with users																							
Deliver																							
Refining PSS																							
Developing guidlines for future																							
Report writing																							
Presentation preparation																							

March 2 Kickoff meeting | May 11 Mid-term | Holiday week | July 7 Green light | August 4 Graduation

The planning for the project is divided into 4 broad phases based on the 4D's method- Discover, Define, Develop and Deliver, as shown in the above Gantt chart. During the process interviews will be conducted with users and experts to deep-dive and investigate the problems faced by hypertensive pregnant women. Qualitative analysis in the form of thematic analysis will be carried out to identify problem areas that need solving. Currently, the outcome is envisioned as a product-service-system or a PSS that aims to motivate pregnant women by solving the problems that are identified in the analysis phase. Testing and validation will be carried out with a small set of 3 to 5 pregnant women to understand their experience with the intervention. As a conclusion, the PSS will be fine-tuned to fit the feedback and future recommendations will be provided based on the results.

4 key dates- kickoff, midterm, green light and graduation day are marked at the bottom on the Gantt chart. The midterm is scheduled on day 47 to fit the availability of the supervising team. The planning also includes a break on 1 week on calendar week 22.

Initials & Name R.U. Khot Student number 5028604

Title of Project A product-service intervention for hypertensive pregnant women

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

The underlying motivation and personal ambition that drove my choice in selecting this graduation project are as mentioned below (in no specific order):

1. The outcome of the graduation project should display my learnings so far- from both design and engineering while exploring the possibilities for prevention or early detection of a medical problem
2. Apply the learnings from electives- context mapping skills and service design in the field of healthcare with the aim to deepen my knowledge on strategic design
3. Learn more about the design and development of introducing lifestyle interventions through behaviour change- a possible direction that I would like to pursue after graduation
4. Improve and display research skills that can help pave way for pursuing PhD after masters

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name R.U. Khot Student number 5028604

Title of Project A product-service intervention for hypertensive pregnant women

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APPENDIX 2

COM-B	Constructs	TDF Domains	Barriers	Enablers	Sources
Capability	Psychological	Knowledge	Lack of knowledge on diet change and health implications		Ayalew et al., 2017; Berenson et al., 2016; Coonrod et al., 2009; Dunlop et al., 2013; Frey & Files, 2006
			Incorrect information on diet change		Ayalew et al., 2017; Berenson et al., 2016; Coonrod et al., 2009; Dunlop et al., 2013; Frey & Files, 2006
			Limited resources with generic information		Muhwava et al., 2019
				Awareness of required modifications from before pregnancy	Al-Akour et al., 2015; Mitchell et al., 2012
		Memory, attention, and decision making	Emotional impact of diagnosis affects ability to process information		Muhwava et al., 2019
			Lose focus on healthy eating after delivery		Muhwava et al., 2019
			Lack of long-term decision making		Muhwava et al., 2019
			Family history, previous diagnosis		Boyd et al., 2020
		Behavioural regulation	Not monitoring progress		Muhwava et al., 2019
			Monitoring ends after pregnancy		Muhwava et al., 2019
		Cognitive difficulties/skills	Language acts as barrier		Boyd et al., 2020
			Lack of self-management of illness		Muhwava et al., 2019

	Physical	Physical	Purchasing and preparing healthy food		Muhwava et al., 2019
			Physical restriction due to medical conditions, postnatal complications, or fatigue		Boyd et al., 2020
Opportunity	Social	Social influences	Lack of social support after the delivery		Muhwava et al., 2019
				Family encouragement and support pre and during pregnancy	Muhwava et al., 2019
	Social/physical	Competing priorities	Limited time		Boyd et al., 2020
			Prioritising family over self, self-neglect		Boyd et al., 2020
	Physical	Environmental context and resources	Limitations or inaccessible resources		Berenson et al., 2016
			Financial constraints		Berenson et al., 2016
			Unhealthy convenience food is cheap and easily available		Muhwava et al., 2019
Motivation	Reflective	Beliefs about consequences	Beliefs about consequences of eating certain foods in relation to pregnancy		Muhwava et al., 2019
			Underestimating impact of healthy eating		Muhwava et al., 2019
				Self-belief about positive consequences of change	Berenson et al., 2016; Khan et al., 2019
				High motivation to protect baby	Muhwava et al., 2019
		Beliefs about capabilities	Lacking belief in making change		Muhwava et al., 2019

			Stress reduces perceived self-efficacy		Muhwava et al., 2019
				Self-doubt on correctly identifying healthy foods	Berenson et al., 2016
		Social role and identity	Health condition evokes emotions of failure and threatens image of being ideal parent		Muhwava et al., 2019
				Women identify as caregivers	Muhwava et al., 2019
		Intention	Intention to change reduces or ends after pregnancy		Muhwava et al., 2019
				Intention to continue with new healthy habits	Berenson et al., 2016; Khan et al., 2019
		Goals		Creating plans to follow with a goal in mind	Boyd et al., 2020
		Optimism		Negative thoughts based on family history and past experiences	Muhwava et al., 2019
	Automatic	Reinforcement		Successful pregnancy outcome as a reward	Muhwava et al., 2019
				Successful outcomes in behaviour tracking of goals	Boyd et al., 2020
		Emotional response	Overwhelmed by required radical changes in short timeframe		Muhwava et al., 2019
			Impulse to eat due to pregnancy cravings		Muhwava et al., 2019