A Conceptual Framework Architecture for AI-Based Remote Patient Monitoring in Diabetes (RPM-D): Gap Analysis and Feasibility Assessment

Mrinmoy Roy[1]*, Savdeep Vasudeva[2], Mohit Jamwal[3]

Department of Management Science Research, Mittal School of Business, Lovely Professional University, Punjab, India

Annexure I

Characteristic	Number
Gender	
Male	9
Female	6
Age	
30-40	2
41-50	9
51-60	4
Years in practice	
1 to 10	4
11 to 20	9
21 to 30	2
Number of diabetes patients seen/ day	
<10	7
10 to 25	5
25 to 40	2
>40	1
General Physicians (GP)	10
Diabetologists/Consultant Physicians (CP)/MD	3
DM Endocrinologists	2

Table 1: Selected characteristics of 15 Physicians interviewed.

Sl No.	Statement/ Issue	Number of Physicians who mentioned this issue
	Table 2: Statements/ Issues came out during the Open-ended discussion.	
1	In diabetes management doctors are only concentrating on the disease, making the correct diagnosis & giving the right medications. A tremendous amount of shortage of trained doctors in the country who can provide comprehensive diabetes care and management of the disease.	5
2	Diabetes treatment is not just writing prescriptions for tablets or insulin, which is just 20% of the whole job but basically providing individualised care by knowing economic condition, education level, do's, don'ts, wants and needs.	8
3	Diet plays a major role, it changes from place to place, community to community, religion to religion, belief to belief and exercise level is another important when lifestyle change caters to 50% of the whole treatment. Any Doctor can't provide that at the individual level.	12
4	Motivating patients to manage their mental state is another important factor. Nowadays we need not just a doctor but a dietician, educator, nurse, podiatrist, ophthalmologist, and cardiologist as Diabetes is a metabolic disorder which is basically vascular and cardiometabolic	13
5	We need a comprehensive approach, only one mobile application may be addressing diet and exercises but cannot do everything, it's not something people like to look into, not like candy crush or pleasant Tiktok videos or even WhatsApp or other videos which people will get hooked on and look from time to time which makes them happy.	15
6	Getting back healthy is something that is really not felt by patients' minds, exercises are tiring, a strict diet regime does not make satiety centres happy when patients eat less, and the body is constantly fighting with the mind and sometimes does things forcibly. The available apps can't solve the real issues, probably they only cater to <1% of tech-savvy people.	14
7	Out of 8760 available hours in one calendar year, so-called healthy people spend only 1-2 hr with the doctor, how that doctor can provide hand-holding solution for any Non-Communicable Disease such as Diabetes? There should be a solution which will be absolutely individual do not have one size fits all.	10
8	Most of the Apps are made by Tech companies where individualistic approaches are lacking, something related to motivating and handholding the patients. Most of the time patients lost interest after wearing or using the apps for 6-8 months.	6

Characteristic	Number
Table 3: Selected characteristics of 15 Diabetic Patients interviewed.	
Gender	
Male	10
Female	5
Age	
40-55	2
56-70	9
71-85	4
Years since diabetes first detected	
1 to 10	10
11 to 20	4

21 to 30	1
Diagnosis	
Type 1	1
Type 2	13
Gestational Diabetes	1
Type of education	
School/ Intermediate Level	2
PUC/ High School Level	3
College/ UG Level	3
University/ PG Level	3
Ph.D./ Highest Education Level	1
Diploma/ Professional Certification Level	3
Total Experience in using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems	
<0.5 Year	3
0.5-1 Year	2
1-3 Years	5
3-5 Years	3
5 Years+	1
Type of Experience using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems	
By self	9
By someone from the family	2
By peers/ Friends/ Colleagues	1
By someone known from Society	1
By someone unknown from Society	1
Type of Experience using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems benefited to avoid emergency medical conditions through user-centric vital health parameters it provides	
By self	9
By someone from the family	1
By peers/ Friends/ Colleagues	2
By someone known from Society	1
By someone unknown from Society	1
Duration of using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems regularly for a number of hours/ day	
< 6	4
6 to 10	5

11 to 15	2
16 to 20	1
21 to 24	2
>6	1

Time of mostly using AI-based Smart wearables/ Smart Watch/ Health of Fitness Apps/ Remote Patient Monitoring Systems

Early Morning Hours	1
Morning Hours	3
Day Time	7
Afternoon	1
Evening	1
Night	1
Late Night Hours	1

Type of physical state while using AI-based Smart wearables/ Smart Watch/ Health of Fitness Apps/ Remote Patient Monitoring Systems

Sleeping	1
Exercise/ Walking	5
Eating	1
Office Hours	1
Leisure	1
Anytime	6

Form of AI-based Smart wearables / Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems most suitable for

Glasses	1
Rings	2
Armbands	3
Watch	8
Non-invasive Skin Patches	1

Self-monitoring vital health parameters measurement through AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems

Continuous Blood Pressure	3
Pulse Rate	5
Respiratory Rate	2
Blood Saturation	1
Heart Rate variability	2
Pulse Pressure	1
Temperature	1

Table 4: Statements/ Issues came out during the Open-ended discussion

Sl No.	Statement/ Issue	Number of Patients who mentioned this
1	After using AI-based Smart wearables/Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems, visits to hospitals/clinics and consulting my Medical Doctor for basic medical check-ups/ preventive diagnoses are reduced.	3
2	My Medical Practitioner/ Doctor recommends using AI-based Smart wearables/Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems for preventive diagnosis/ monitoring for me and my family.	5
3	I believe there is an urgent need of using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for preventive diagnosis/ monitoring for me and my family	9
4	I and my family want to use AI-based Smart wearables/Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems for preventive diagnosis/ monitoring.	13
5	The main reason for using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems is it provides various user-centric vital health parameters beneficial for preventive diagnosis/ monitoring to avoid emergency conditions.	15
6	I believe me and my family and friends should use AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for continuous monitoring	12
7	I am aware of the functionality of AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems and I can explain to others	14
8	There should be an uninterrupted workflow and platform interoperability for AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for the quality & efficiency of the service it provides	3
9	There should be secured user data transactions, repository access and monitoring through AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for increasing the usability	10
10	The AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems usually are in direct physical contact, so the enclosure material needs to be biocompatible and should withstand temperature changes, and humidity and refrain from potential hazards.	13
11	The AI-based Smart wearables/Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems should be strong enough to protect internal electronic circuitry & shield the human body from any electromagnetic radiation.	14
12	The AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems should have an intuitive user interface.	11

Annexure II

Table 1: Questionnaire & Model Constructs with Scale of Measurement.

Questionnaire and Model Constructs		Scale of Measurement				
UX = User Experience	Experience and awareness about the functionality of using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems by self/ peers/ family/ someone from Society	1	2	3	4	5
UX1	I experienced using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems	By someone unknown from the society	By someone known from the society	By my peers/ friends/ colleagues and by my patients (For Doctors and Caregivers)	By someone from my family	By myself

		By someone unknown from the society	By someone known from the society	By my peers/ friends/ colleagues and by my patients (For Doctors and Caregivers)	By someone from my family	By myself
UX2	I experienced using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring systems benefited avoiding emergency medical conditions through the user-centric vital health parameters it provides.					
UX3	I am aware of the functionality of AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems and I can explain to others	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
QD = Quality by Design	Different Qualitative parameters such as uninterrupted workflow, platform interoperability and intuitive user interface are to be incorporated in the design for the quality and efficiency of services they provide					
QD1	There should be an uninterrupted workflow and platform interoperability for AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for the quality & efficiency of the service it provides	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
QD2	The AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems should have an intuitive user interface.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
PCD = Patient-Centric Design thinking	Parameters that show Patient-centric design thinking for example biocompatible material, strong body to protect internal electronic circuits and shielding radiations.					
PCD1	The AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems usually are in direct physical contact, so the enclosure material needs to be biocompatible and should withstand temperature changes, and humidity and refrain from potential hazards.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
PCD2	The AI-based Smart wearables/Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems should be strong enough to protect internal electronic circuitry & shield the human body from any electromagnetic radiation.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
EC = Ethical Consideration	There should be secured user data transactions, repository access and monitoring through AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for increased usability.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
U = Usability	The reason and need, firm belief to use and the urgency of requirement and reducing hospital visits through services they provide.					
U1	The main reason for using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems is it provides various user-centric vital health parameters beneficial for preventive diagnosis/ monitoring to avoid emergency conditions.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

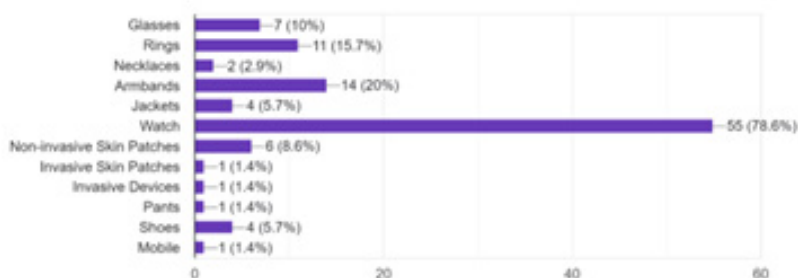|						
U2	I believe there is an urgent need of using AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for preventive diagnosis/ monitoring for me and my family	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
U3	After using AI-based Smart wearables/ Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems, visits to hospitals/clinics and consulting my Medical Doctor for basic medical check-ups/preventive diagnoses are reduced.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
U4	I and my family want to use AI-based Smart wearables/Smartwatches/ Health or Fitness Apps/ Remote Patient Monitoring Systems for preventive diagnosis/ monitoring.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
U5	I believe me and my family and friends should use AI-based Smart wearables/ Smart Watch/ Health or Fitness Apps/ Remote Patient Monitoring Systems for continuous monitoring	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Annexure III

Figure 1. The most suitable form of AI-based Smart wearables/Smart watch/Health or Fitness Apps/ Remote Patient Monitoring systems.
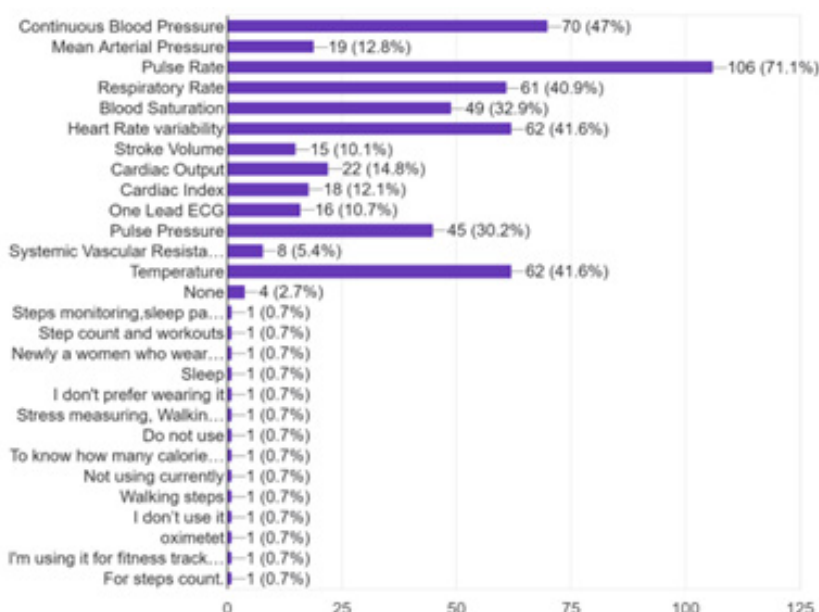

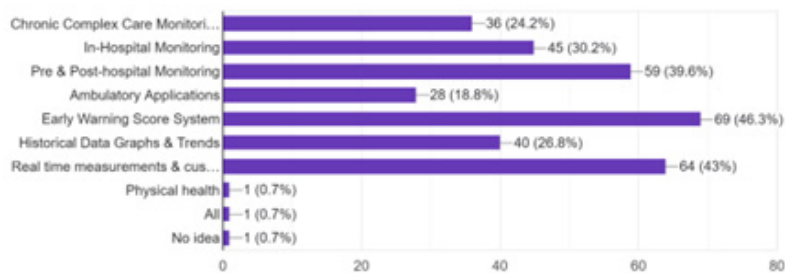**Figure 2.** Health vitals monitored or feature to be included in most RPM-D.

Figure 3. AI-based Smart wearables/ Smart watch/ Health or Fitness Apps/ Remote Patient Monitoring systems solutions.
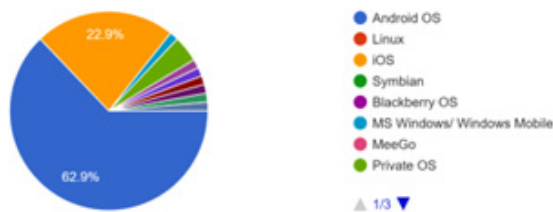

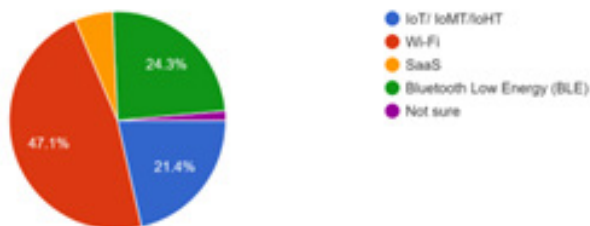**Figure 4.** Preferred Operating systems for most RPM-D.

Figure 5. Most preferred connection parameters for uninterrupted service of RPM-D.
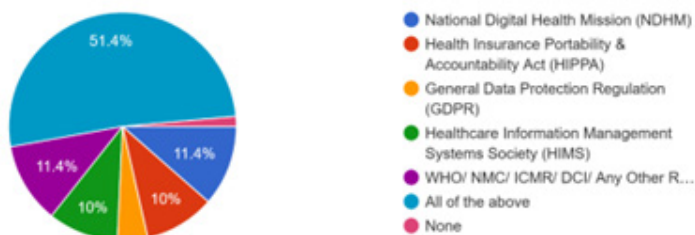

Figure 6. For Ethical considerations, preference of RPM-D system should comply with.