

Acceptance and Implementation of Tele-rehabilitation in the Community: A Feasibility Study

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Background and aims

Community-based rehabilitation services frequently encounter disruptions following acute hospital care. Local research indicates a low adherence rate of approximately 28% at one year¹, attributed to functional, social, financial, and perceptual barriers. Telerehabilitation offers a continuous care model, overcoming geographical, physical, and economic barriers and potentially improves patient motivation and engagement through exergaming. In this study, we evaluate the acceptability, feasibility, and safety of implementing a home-based tele-rehabilitation program among patients attending day rehabilitation centers across Singapore.

Methods

A prospective, multi-centred, clinical feasibility pilot study was carried out, eligible participants were receiving outpatient rehabilitation services at designated day rehabilitation centers with capability of performing activities under minimal assistance. Prior to device deployment, patients and their caregivers participated in onboarding sessions using Evolv Rehabkit device. The devices were then installed at the participants' homes for four weeks of training, during which weekly remote monitoring was conducted by physiotherapists. The intensity of home exercises was analyzed and the pre- and post-training outcome measures were compared to evaluate changes.

Results (interim)

Following a 30-day tele-rehabilitation therapy, remarkable progress was noted in a 69-year-old male patient.

His Modified Barthel Index (MBI) improved from 92 to 98, indicating enhanced independence.

The Short Physical Performance Battery (SPPB) score reached a perfect 12/12 from 11/12, and Berg Balance Scale (BBS) score rose from 49 to 56.

Right and left grip strength were improved from 22.3kgf to 25.67kgf and from 19.37kgf to 22kgf respectively. (Refer Table 1)

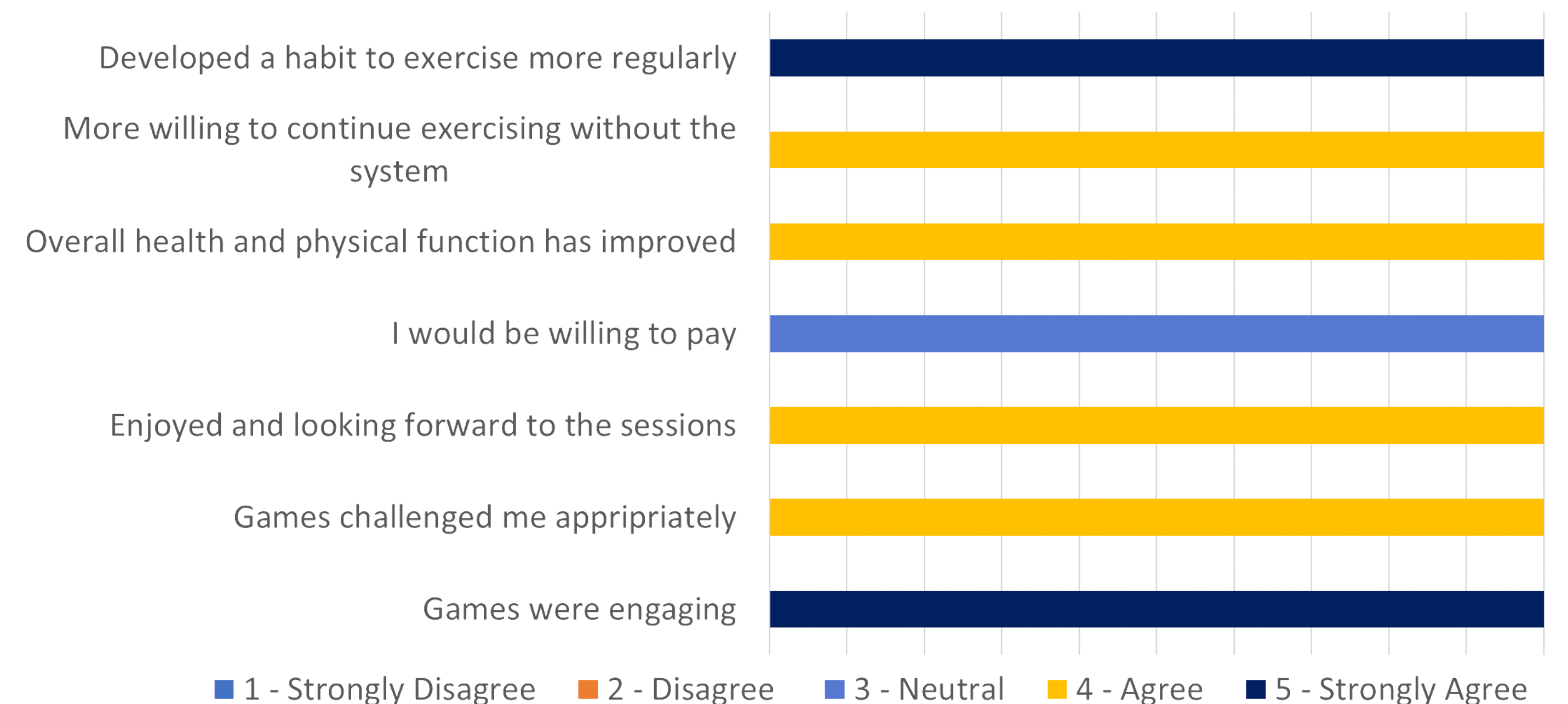
His daily average exercise duration was 27.46 minutes, with a high compliance rate of 90%.

Additionally, patient feedback from the tele-rehabilitation program was highly positive. (Figure 1) Notably, the program fostered a willingness to continue exercise independently, even without the tele-rehabilitation system, indicating the potential for promoting long-term adherence to active lifestyle.

Table 1 : Outcome measures

Baseline Variable	Week 0 (Baseline)	Week 8 (Post home tele-rehabilitation therapy)	Week 18
Modified Barthel Index	92	98	100
Short Physical Performance Battery			
Side by side stand	> 10 sec	> 10 sec	> 10 sec
Semi-tandem stand	> 10 sec	> 10 sec	> 10 sec
Tandem stand	> 10 sec	> 10 sec	> 10 sec
Gait speed	3.08 sec	4.33 sec	4.91 sec
Chair stand test	13 sec	8.67 sec	16.11 sec
Berg balance test /56	49	56	56
Grip strength			
Right Hand	22.3kgf	25.67kgf	27.6kgf
Left Hand	19.37kgf	22.0kgf	23.3kgf

Figure 1: Feedback collected from participant



Conclusion

Telerehabilitation is an effective modality to continue rehabilitative care post-acute hospital phase. The significant improvements observed in the patient's functional and physical parameters after the therapy demonstrate the system's potential. With a high compliance rate, this approach could potentially overcome the common barriers faced by day rehabilitation patients and enhance their self-efficacy. However, larger scale studies are needed to validate these preliminary findings and explore the long-term benefits of such an intervention in the community rehabilitation system.

References

1. Koh GC, Saxena SK, Ng TP, Yong D, Fong NP. The effect of duration, participation rate and supervision during community rehabilitation on functional outcomes in the first post stroke year in Singapore. Arch Phys Med Rehabil 2012;93:279-86

Ng Teng Fong Healthcare Innovation Programme

Pillar B Track 2: Strategic Innovation

Project Final Report

Congratulations on completing your project! As part of the requirement of NTF HIP grant funded projects, you are required to submit a final report no later than three (3) months from the indicated completion date of the project. You are required to inform the NTF HIP Secretariat of any publication and/or presentation relating to the funded project within 1 month of the publication and/or presentation. If you had not already done so, please include in this report. Please note that you may be asked for updates for up to 5 years after the completion date of the project for the purposes of management reports.

All sections must be completed. Indicate "NA" where a particular section is not applicable.

Strategic Innovation Programme Title	NG TENG FONG HEALTHCARE INNOVATION PROGRAMME (INNOVATION TRACK 4 - STRATEGIC INNOVATION TRACK)				
Project Code	NTF_SIP_EMRM_P3				
Project Title	Proof of Value (POV) of feasibility and implementation of telerehabilitation model in community setting using Evolv Rehabkit				
Project Lead Name	Dr Ong Poo Lee				
Project Lead Designation	Consultant				
Project Lead Department	Rehabilitation Medicine				
Project Lead Email	Poolee_ong@ttsh.com.sg				
Project Team (Please provide names of all partners, external collaborations, sponsors that contributed in the project)	S/N	Name of Team Member	Role (Eg Co-PI, Member, Industrial Partner, Collaborator, Sponsor etc)	Name of Organization	Healthcare Family Group (Eg Allied Health, Ancillary Care, Administration, Medical Doctor, Nursing, Pharmacy)
	1	Dr Ong Poo Lee	PI	TTSH	Medical Doctor
	2	Christopher Kuah Wee Keong	Co-I	TTSH	Allied Health
	3	Ruth Ong	Co-I	TTSH	Allied Health
	4	Ramesh Duraisamy	Co-I	Handicaps Welfare Association (HWA)	Allied Health
	5	Ho Chung Yin Benedict	Co-I	Home Nursing Foundation (HNF)	Allied Health
	6	Rena Sim	Co-I	Renci Day Rehabilitation Centre (DRC)	Allied Health
Applicable Specialties or Disciplines	Rehabilitation Medicine				
Name / Email of Project Contact Person (s)	Please leave it blank if it is the same as the Project Lead				
Original Project Period	Start Date: 01/03/2023 End Date: 29/02/2024				

Approved Revised Period (if any)	Revised Start Date: 01/03/2024 Revised End Date: 30/12/2024
Project Category (Refer Tagging Playbook attached below for more information)	<p>Primary Category Technology</p> <p>Refer attached Tagging Playbook for metadata based on chosen category</p> <p>Secondary Category (if applicable) Select a Secondary Category from the drop-down list</p> <p>Refer attached Tagging Playbook for metadata based on chosen category</p> <p>Keywords Tele-rehabilitation</p>
Date of Report	18/03/2025






Child_Taxonomy Tagging Playbook_v

(A) PROJECT SUMMARY

Summary	This project evaluates the feasibility and effectiveness of a telerehabilitation model using EvolvRehab platform in community setting. By providing therapist prescribed exercises with remote monitoring, it improves functional outcomes, balance and strength while enhancing patient engagement. This study demonstrates high compliance, time saving, and manpower cost avoidance, highlighting the potential for scalable rehabilitation solutions.
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(B) PROJECT REPORT

Background	<p>It has been well documented that hospital-based rehabilitation services are effective ways of providing therapy in people with disabilities. However, factors such as costs and manpower shortages, prevent such population from accessing such services. Home-based telerehabilitation services has emerged as a promising alternative that uses communication technology such as a mobile phone or tablet to provide cost-effective and engaging exercises at home.</p> <p>This study aims to evaluate the feasibility and acceptance of telerehabilitation in the community through the collaboration between TTSH, HWA, HNF and Renci DRC. The intervention aims to address challenges in conventional rehabilitation, such as limited access to rehabilitation, poor exercise adherence and resource-intensive face-to-face therapy by implementing a home-based therapy programme via the EvolvRehab platform.</p>
Aims and Objectives	The aim of this study is to examine the feasibility of delivering a tele-rehabilitation program in a day rehabilitation centre in Singapore. We will focus on finding out the acceptability of the tele-rehabilitation program to patients, caregivers and healthcare professionals involved, as well as factors influencing the implementation ease.
Methods	A total of ten participants were recruited and they underwent a 30-days telerehabilitation programme with daily therapist-prescribed exercises and weekly remote monitoring. Functional outcomes were assessed at baseline (Week 0), post-intervention (Week 8), and follow-up (Week 18) using the Modified Barthel Index (MBI), Short Physical Performance Battery (SPPB), Berg Balance Scale (BBS), and grip strength. Participants' usability and levels of engagement were evaluated using the System Usability Scale (SUS) and Patient Reported Outcome Measures (PROMS).
Results	At the follow-up stage, significant improvements in mean MBI (75.8 to 81.2, p = 0.019), BBS (33.3 to 38.0, p = 0.037), and hand grip strength (15.1kg to 18.0kg, p=0.005) were observed. High exercise compliance with 90% of participants

 <p>Pillar B - ROI_Outcome</p>	<p>completing at least 70% of exercise sessions for > 20 minutes daily were also observed. Lastly, PROMs revealed high levels of exercise engagement, with participants finding the games challenging and enjoyable, although concerns regarding costs were raised.</p> <ol style="list-style-type: none"> 1. Improved functional independence: MBI showed a statistically significant improvement indicating increased functional independence among participants 2. Improved balance and mobility: Significant improved in BBS demonstrating enhanced balance and reduce fall risk 3. Increased strength: Improved upper limb muscle strength evidence by improved hand grip strength, which is crucial for daily activities 4. Improved exercise adherence: 90% of participants completed at least 70% of their prescribed exercise sessions, with each lasting more than 20 minutes daily 5. Acceptance of gamified telerehabilitation system as evidence by SUS score and qualitative feedback <p>This telerehabilitation model reduces the need for face to face therapist supervision, allowing physiotherapist to focus on more complex cases while patient engage in structured rehabilitation at home.</p> <p>Patient using telerehabilitation saved approximately 4 hours per month, which would have otherwise been spent on travelling to attend in-person therapy sessions at day rehabilitation centre.</p>
<p>Conclusion</p>	<p>This study highlights the feasibility and benefits of gamified telerehabilitation in improving mobility, balance, and strength in the community settings. High compliance and engagement underline its potential and addresses usability concerns and perceived value which is essential for broader adoption and scalability.</p>
<p>Lessons Learnt</p>	<p>Proper patient selection is important as a certain level of cognition and spatial awareness is require in order to engage with the games and comply with the exercise programme.</p>
<p>Next Plans</p>	<p>The next phase of this project include implementation of telerehabilitation from tertiary hospital directly to day rehab centre and home. However, we are putting the grant application on hold due to constraints related to our limited manpower and resources for this next phase of the study and will explore it further when circumstances allow.</p>
<p>Additional Information and Project Materials</p>	<p>Poster Presented at ISPRM 2024 and accepted to RehabWeek 2025</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>ISPRM-2024_poster-rehabweek_evolv.d presentation-evolv.t</p> </div> <div style="text-align: center;">  <p>ocx</p> </div> </div>

(C) PROJECT BUDGET ACCOUNT SUMMARY

You no longer need to submit Statement of Account (SOA) with this report, NTF HIP Secretariat will request from 1FSS directly.

Category	IO code (TF22HIP154)	Original Approved Budget (\$)	Revised Approved Budget (\$) (Please leave it blank if same as original approved budget)	Total Expenditure (\$) (This should include all monies expended for this project. All payments must have been completed.)	Balance (\$)
Manpower	TF22HIP154MP	\$40,000.00	\$64,000.00	\$63,627.05	\$372.95
Equipment	TF22HIP154EQ	\$42,600.00	\$42,600.00	\$37,614.40	\$4,985.60
Consumables					
Utilities					
Miscellaneous	TF22HIP154OM	\$17,400.00	\$17,400.00	\$9,673.05	\$7,726.95
Total		\$100,000.00	\$124,000.00	\$110,914.50	\$13,085.50

- I had submitted all the claims to 1FSS and the reimbursement had completed. I am ready to close the account(s)
- I had submitted all the claims to 1FSS and pending completion of the reimbursement. I will be ready to close account (s) on [Click or tap to enter a date.](#)

Centre for Healthcare Innovation Learning & Development System (CHILD)

CHILD is a national knowledge management and sharing initiative made possible through the kind support of the Ministry of Health and all public healthcare clusters. CHILD aims to be the first touch-point for any healthcare innovator, serving as an open repository for healthcare innovation, improvement and productivity. CHILD is open to anyone (e.g. local and international healthcare institutions, industry players, academia and the public) keen to share, learn and collaborate. It enables this through two broad functions:

1. **Sharing** - A live, central repository of information including but not limited to best practice stories, projects (both completed and ongoing), publications and tools; and
2. **Collaboration and Creation** – A online space for like-minded individuals and/or institutions to connect with each other to work on cross institution collaborations and innovation initiatives, and harness the collective knowledge of the community to make practice-based decisions.

Given there is no other local reference site in Singapore, this knowledge management (KM) platform will be one of a kind. The hope is that one day, through the contributions from everyone, CHILD will become the leading platform for sharing knowledge related to healthcare innovation, improvement and productivity! Hence, in contribution to this effort for co-learning to build synergy across healthcare clusters, all NTF HIP funded projects will be listed on CHILD, where suitable.

Declaration and Endorsement

I declare that all the above information provided is true and complete to the best of my knowledge. I have also enclosed all necessary documents in support of my submission. I agree to share my project on CHILD (excluding Part C Budget Information).

By submitting content to CHILD, I acknowledge that my consent will grant permission to the CHILD administrative team to publish and store my material for viewing, downloading and publicising to the, users of CHILD and the public. I acknowledge that it does not contain any sensitive or confidential information such as patient details, detailed financial data etc. and that my institution has deemed it suitable for public visibility.

I would like to share the information of my project on CHILD

- Immediately as I am ready to share the information with the public.
- Only when I have published my manuscript.
 - Estimated date to publish: 01/09/2025 (not later than 24 months after grant completion)


Name of Project Lead : Dr Ong Poo Lee

Signature : 

Date : 18/03/25

Endorsement by Programme Director

Name of Programme Director: Dr Loh Yong Joo

Signature : 


Date : 28 Mar 2025

Name of Programme Director: Doreen Yeo

Signature : 

Date : 28 Mar 2025

Name of Programme Director: Dr Lee Liang Tee

Signature : 

Date : 28-03-2025

Ng Teng Fong Healthcare Innovation Programme
Projected Outcome Indicator Form

Projected Outcomes / KPIs

1 Manpower Cost Avoidance					Projected avoidance by the proposed project			Potential avoidance when scaling up		
Projected Outcomes / KPIs	No. of FTE avoided	Cost/ FTE/ month	Cost avoided/ FTE per year	Justification	Estimated Manpower saving if scale to cluster (no. of FTE per year)	Estimated Manpower saving if scale to cluster (cost per year)	Justification			
E.g. Avoid 1 FTE Physiotherapist time/	1	\$ 10,000.00	\$ 120,000.00	With the implementation of exoskeleton device, where 1 PT instead of 2 will be required to attend to the patient each rehab session thus avoiding the need to employ additional PT as caseloads increase	3	\$ 360,000.00	There are 3 such clinics at the cluster level			
1 Avoid 0.1 FTE Physiotherapist time	0.1	\$ -	\$ -	Additional therapy for 12 hours in a month using Evolv Device as part of telerehabilitation at home, avoided the need of physical face to face visit by PT	1	\$ -	Estimate 10 Day rehab centre at cluster level			
2		\$ -	\$ -			\$ -				
3		\$ -	\$ -			\$ -				
4		\$ -	\$ -			\$ -				
5		\$ -	\$ -			\$ -				
Total	0.1	\$ -	\$ -		1	\$ -				

2 Time Saving or Process Avoidance/Reduction (from Hospital's perspective)					Projected saving by the proposed project			Potential saving when scaling up		
Projected Outcomes / KPIs on the productivity gaining	Time saving to the hospital (from process avoidance/reduction) (no. of hours)	Cost Saving to the hospital per unit i.e. per staff/ session/ test (time saved x cost/unit)	Total Cost Saving	Justification	Estimated no of beneficiary at cluster or national level per year	Estimated Cost Saving if scale up to cluster or national level per year	Justification			
E.g. Reducing treatment session from 6 to 5 sessions	1.5	\$ 1,000.00	\$ 1,500.00	With the predictive AI model based on patient profile, the patients will be able to receive more targeted and effective treatment	30000	\$ 45,000,000.00	There are about 30,000 patients undergoing such treatment at the national level			
E.g. Improved staff productivity	1095	\$ 15.00	\$ 16,425.00	With the implementation of RPA to automate manual task, data can be churned out at a faster speed, improving turn around time and reducing backlog	10	\$ 164,250.00	There are 10 such clinics at the cluster level			
1		\$ -	\$ -			\$ -				
2		\$ -	\$ -			\$ -				
3		\$ -	\$ -			\$ -				
4		\$ -	\$ -			\$ -				
5		\$ -	\$ -			\$ -				
Total	0	\$ -	\$ -		0	\$ -				

3 Time Saving or Process Avoidance/Reduction (from Patients' perspective)					Projected saving by the proposed project			Potential saving when scaling up		
Projected Outcomes / KPIs	Time saving to the patient (from process avoidance/reduction) (no. of hours)	Cost Saving to the patient per unit i.e. hour/ session/ test (time saved x cost/unit)	Total Cost Saving per patient	Justification	Estimated no of beneficiary at cluster or national level per year	Estimated Cost Saving if scale up to cluster or national level per year	Justification			
E.g. Reducing length of stay in hospital	10	\$ 200.00	\$ 2,000.00	Patient will be able to be discharged earlier with the new rehab exercise done post TKR operation	40000	\$ 80,000,000.00	There are about 40,000 patients undergoing TKR every year at the national level			
E.g. Reliable evaluation of gene signature on FFPE sample allows the use of assay as a routine management for women with small node-negative triple negative tumors. Thus, omit the need for chemotherapy for low risk cancer patient.	192	\$ 52.00	\$ 9,984.00	Direct cost savings and employment-related opportunity cost by omitting at least 4 cycles of chemotherapy	509	\$ 5,081,856.00	12,735 individuals newly diagnosed with breast cancers every 5 years, assuming 20% of these group have low risk cancer, 2,547 individuals newly diagnosed per 5 years (i.e. 509 per year) will be able to omit chemotherapy at the point of diagnosis.			
E.g. Improved Accessibility to Care	2	\$ 50.00	\$ 100.00	With improved queue system, patients can be kept up-to-date with the queue journey, giving them better control of their schedule and reduce wait time	500000	\$ 50,000,000.00	There is an average of 500,000 patients seen per year			
1 Improved Accessibility to Care	4	\$ 100.00	\$ 400.00	Avoid the need to travel to day rehab centre and back home, can potentially replace one physical session to telerehabilitation, while maintain one physical visit per week at DRC	500	\$ 200,000.00	Estimate on average of 50 suitable patients per DRC per year can benefit from telerehabilitation, average 500 patients across cluster per year			
2		\$ -	\$ -			\$ -				
3		\$ -	\$ -			\$ -				
4		\$ -	\$ -			\$ -				
5		\$ -	\$ -			\$ -				
Total	4	\$ 100.00	\$ 400.00		500	\$ 200,000.00				

4 Better Clinical Outcomes leading to Cost Avoidance by Patients

Projected saving by the proposed project					Potential saving when scaling up		
Projected Outcomes / KPIs	Avoidance of future sessions/ therapy/ test etc.	Cost per future session/ therapy/ test (i.e. medical fee, transport cost)	Total cost savings	Justification	Estimated no of beneficiary at cluster or national level per year	Estimated Cost Saving if scale up to cluster or national level per year	Justification
E.g. Retardation of CKD (Chronic Kidney Disease) progression, with delay in onset of ESKD (End Stage Kidney Disease) by 10 years or more.	10	\$ 1,500.00	\$ 15,000.00	\$1,500 treatment fee per year. With delay of onset of ESKD by 10 years or more, each patient can save more than \$15,000 in total.	1420	\$ 21,300,000.00	Based on Singapore Renal Registry Annual Report 2022 published by HPH, a total of 1,420 patients newly diagnosed with Kidney Failure/ESKD, which could be benefitted when stepped in at an earlier stage by retarding the progress.
E.g. Reduced readmissions	1	\$ 5,000.00	\$ 5,000.00	The app enables patients to self manage their medication therapy and resolve drug related problems in patients with polypharmacy thus reducing readmissions.	10000	\$ 50,000,000.00	There is an average of 10,000 patients with polypharmacy
1		\$ -	\$ -			\$ -	
2		\$ -	\$ -			\$ -	
3		\$ -	\$ -			\$ -	
4		\$ -	\$ -			\$ -	
5		\$ -	\$ -			\$ -	
Total	0	\$ -	\$ -		0	\$ -	

Benefit to Cost Table	
Total Projected Cost Saving by the proposed	\$ 400.00
Grant Amount requested	\$ -
Ratio	#DIV/0!