IS210 - Business Process Analysis and Solutioning
Business Process Engineering Case Study
Cubes Hospital

G2T1

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1. Company Introduction and Purpose of BPE Team

1.1 Company Introduction

Cubes Hospital (hereafter referred to as the "Hospital") was opened in 1998 as an integrated healthcare hub in central Singapore. Hospital offers a comprehensive range of medical services and specialties. It is Hospital's priority to provide high quality healthcare and conductive healing environment.

Hospital's vision is to help people live a long, healthy life and support them with thoughtful, dignified care to the end. Hospital's mission is to provide good quality, affordable and hassle-free healthcare with science, love and wisdom.

Currently, the bed demands in Hospital exceeds its capacity, leading to delayed in-patient admissions and cancellations of surgical procedures. This caused Patient to be dissatisfied, thus affecting its reputation and competitive edge.

1.2 Purpose of BPE Team

A faster turnaround time during patient discharge may allow more beds to be freed up in the process. Hence, Hospital's management has set up a task force, Business Process Engineering (BPE) Team, to study the current Patient Discharge Homebound (PDH) Process and to find viable solutions to improve the process.

2. Process Redesign Goals, Management Decisions or Policies, Performance Targets

2.1 Process Redesign Goals

1. To find out the issues with the existing PDH Process.
2. To resolve the conflicts between different departments.
3. To reuse the existing IT infrastructure if possible.
4. To minimize manual paper forms and duplicate information in the various systems.
5. To seamlessly integrate information across the various systems.
6. To improve relationship with Patient, Caregiver and Hospital employees.
7. To improve the discharge process efficiency and to have sufficient beds for inpatient.

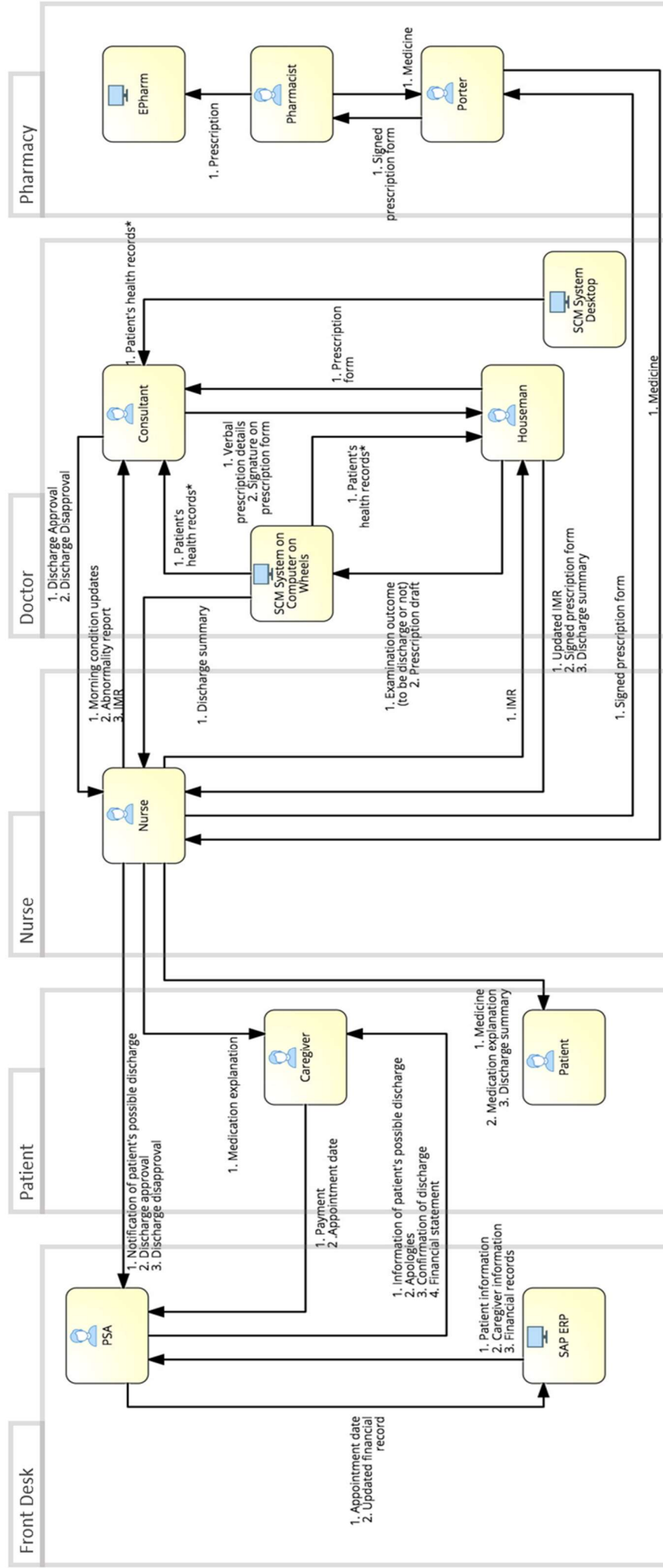## 2.2 Management Decisions or Policies

1. Patient/Caregiver must settle payment and schedule the next appointment before being discharged.
2. Deployment of new technology should only be implemented after careful consideration of benefits, costs and risk.

2.3 Performance Targets

The PDH process can be divided into three sub-processes: the morning check-up process by Consultant and Houseman, the medicine preparation process by Porter and Pharmacist and Caregiver settlement process by Patient Service Associate (PSA). Our main goal is to speed up all three sub-processes so as to increase the efficiency of the whole PDH process. The following are the specific performance targets and business performance metrics.

No.	Performance Targets	Business Performance Metrics
1	Reduce the average time of the PDH process by 30%.	Average time of the PDH process
2	Reduce the average cost per patient in the PDH process by 30%.	Average cost per patient in the PDH process
3	Reduce the average time of the morning check-up process by at least 20%.	Average time taken to complete all the tasks in the morning check-up process.
4	Reduce the bottleneck of the PDH process, which is the medicine preparation process, by 20%.	Average time for medicine to be prepared and delivered to Nurse.
5	Reduce manual activities with the use of automation by at least 2 activities	1) Number of manual activities reduced 2) Number of automated activities added
6	Reduce the average time of the Caregiver settlement process by at least 20%.	1) Average time taken for PSA to contact the Caregiver. 2) Average time taken to settle payment and appointment schedule. 3) Average time of the whole Caregiver settlement process

3. As-is Collaboration Model

Front Desk | Patient | Nurse | Doctor | Pharmacy

Pharmacy
- EPharm
- Pharmacist
- Porter
- 1. Medicine
- 1. Prescription
- 1. Signed prescription form
- 1. Medicine

Doctor
- Consultant
- Houseman
- SCM System Desktop
- SCM System on Computer on Wheels
- 1. Patient's health records*
- 1. Prescription form
- 1. Discharge Approval / 2. Discharge Disapproval
- 1. Verbal prescription details / 2. Signature on prescription form
- 1. Patient's health records*
- 1. Patient's health records*

Nurse
- Nurse
- 1. Morning condition updates / 2. Abnormality report / 3. IMR
- 1. Discharge summary
- 1. Examination outcome (to be discharge or not) / 2. Prescription draft
- 1. IMR
- 1. Updated IMR / 2. Signed prescription form / 3. Discharge summary
- 1. Signed prescription form

Patient
- Caregiver
- Patient
- 1. Medication explanation
- 1. Medicine / 2. Medication explanation / 3. Discharge summary

Front Desk
- PSA
- SAP ERP
- 1. Notification of patient's possible discharge / 2. Discharge approval / 3. Discharge disapproval
- 1. Payment / 2. Appointment date
- 1. Information of patient's possible discharge / 2. Apologies / 3. Confirmation of discharge / 4. Financial statement
- 1. Patient information / 2. Caregiver information / 3. Financial records
- 1. Appointment date / 2. Updated financial record

*Patients' health records include test results, conditions and x-rays/MRI/CT scans

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4. As-Is scenario, the users involved and the IT applications used
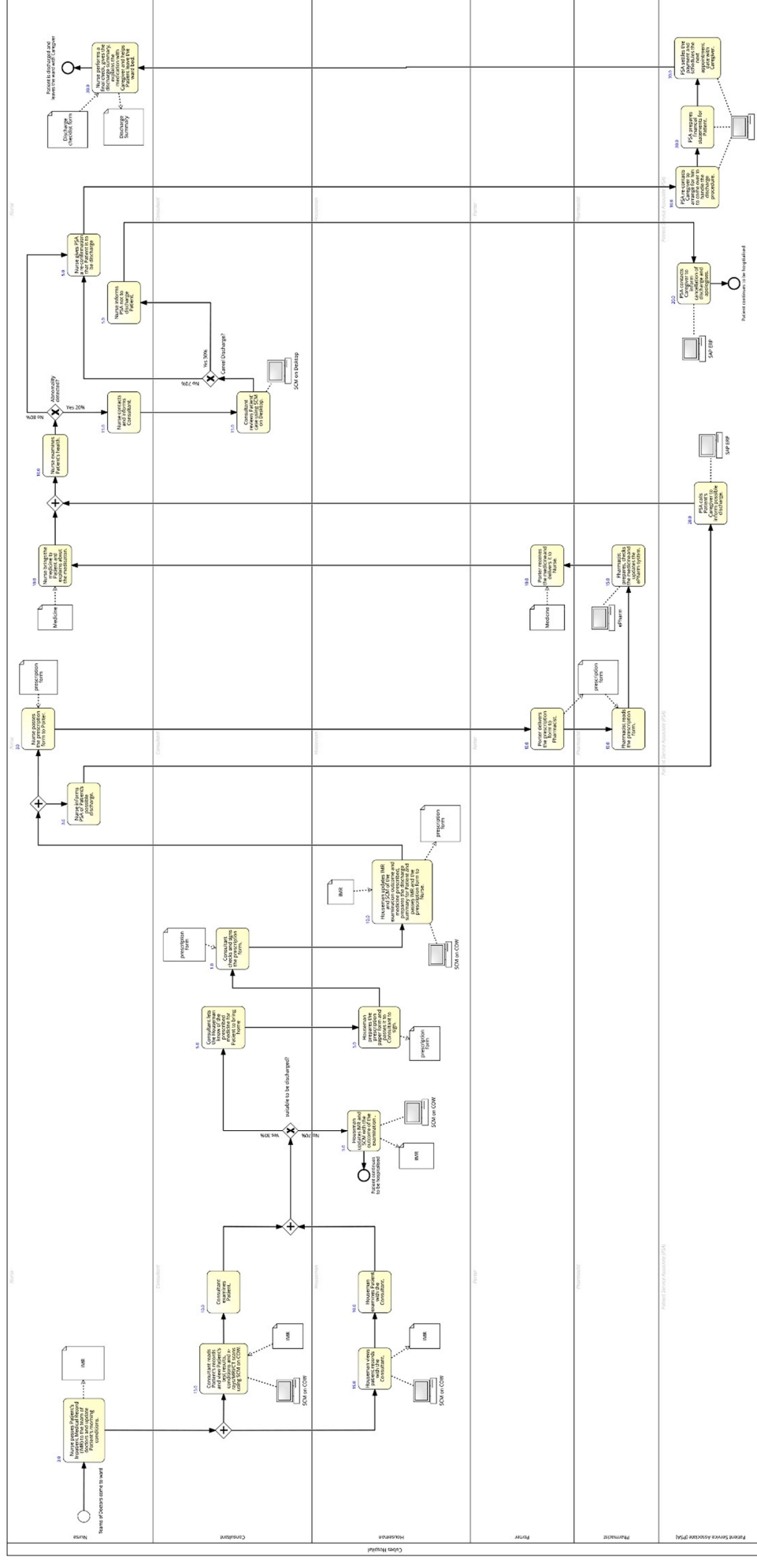
4.1 Roles and IT applications involved

Roles/Resources	Short Description
Consultant	Views Patient's health records and examines Patient's conditions; Prescribes medicines and signs prescription forms.
Houseman	Views Patient's health records and examines Patient's conditions with Consultant; Updates Patient's examination outcome and medicine prescribed on IMR and SCM on COW; Prepares prescription forms and Patient's discharge summary
Nurse	Passes documents to other roles; Explains medication to Patient and Caregiver; Performs a final check before Patient leaves the ward.
Patient Service Associate (PSA)	Contacts Caregiver to inform about Patient's discharge; Settles payment and schedules the next appointment.
Porter	Delivers prescription forms and prescribed medicines between Nurse and Pharmacist
Pharmacist	Prepares and dispenses medicine based on the prescription form; Updates ePharm of Patient's drug use.
Caregiver	Settles payment and schedules the next appointment with PSA.
SAP ERP	Information system providing detailed patient information, Caregiver information, patient financial records, patient admission details and patient appointment scheduling.
ePharm	Assists Pharmacist to prescribe drugs; Archives orders to track Patient's drug use and allergies;
Sunny Clinical Manager (SCM) System	Proprietary off the shelf information system that can be accessed on both Desktop and COW; Storage and display of Patient's lab tests, x-rays/MRI/CT images; Patient discharge summary preparation function;

4.2 Detailed step by step as-is process

Activity Step	Previous Step(s)	Activity Description	Execution Time (min)	Resource Involved
1	-	Nurse passes Patient's Inpatient Medical Record (IMR) to the team of doctors and update Patient's morning conditions.	3	-
2a	1	Consultant reads Patient's records and view Patient's test results, conditions and x-rays/MRI/CT scans using SCM on COW.	15	SCM on COW
2b	1	Houseman views patient records with the Consultant.	15	SCM on COW
3a	2a	Consultant examines Patient.	10	-
3b	2b	Houseman examines Patient with the Consultant.	10	-
4a	3a,3b	Houseman updates IMR and SCM with the outcome of the examination (not to be discharged). Process ends.	5	SCM on COW
4b	3a,3b	Consultant lets the Houseman know of the prescribed medicine for Patient to bring home if Patient is suitable to be discharged.	5	-
5	4b	Houseman prepares the prescription paper form and passes it to Consultant to sign.	5	-
6	5	Consultant checks and signs the prescription form.	1	-
7	6	Houseman updates IMR and SCM of the examination outcome and medicine prescribed, prepares the discharge summary for Patient and passes IMR and the prescription form to Nurse.	10	SCM on COW
8a	7	Nurse informs PSA of Patient's possible discharge.	3	-
9	8a	PSA calls Patient's Caregiver to inform possible discharge.	20	SAP ERP
8b	7	Nurse passes the prescription form to Porter.	3	-
10	8b	Porter delivers the prescription form to Pharmacist.	10	-
11	10	Pharmacist reads the prescription form.	10	-
12	11	Pharmacist prepares, checks the medicine and updates the ePharm system.	15	ePharm
13	12	Porter receives the medicine and delivers it to Nurse.	10	-
14	13	Nurse brings the medicine to Patient and explains about the medication.	10	-
15	9, 14	Nurse examines Patient's health.	10	-
16a	15	Nurse detects abnormality, contacts and informs Consultant.	15	-

17	16a	Consultant reviews Patient' case using SCM on Desktop.	15	SCM on Desktop
18a	17	Nurse informs PSA not to discharge Patient.	5	-
19	18a	PSA contacts Caregiver to inform cancellation of discharge and apologises. Process ends.	20	-
16b, 18b	15, 17	Nurse gives PSA a re-confirmation that Patient is to be discharge when no abnormality is found (step 16b) or after Consultant re-confirms the discharge (step 18b).	5	-
20	16b, 18b	PSA re-contacts Caregiver to arrange for him to come over to handle the discharge procedure.	10	SAP ERP
22	21	PSA prepares financial statements for Patient.	30	SAP ERP
23	22	PSA settles the payment and schedules the next appointment date with Caregiver.	30	SAP ERP
24	23	Nurse performs a final check, gives the discharge summary, explains the medication with Caregiver and helps Patient leave the ward bed.	30	-

As-is PDH Workflow Diagram

Cairns Hospital

Swimlanes: Nurse, Consultant, Houseman, Porter, Pharmacist, Patient Service Associate (PSA)

- Teams of doctors come to ward
- Nurse passes Patient's In-patient Medical Record (IMR) to the team of doctors and update Patient's nursing conditions.
- Consultant reads Patient's records, and view Patient's conditions and x-rays/MRI/CT scans using SCM on COW
- Consultant examines Patient.
- suitable to be discharged? Yes 30% / No 70%
- Houseman update IMR and SCM with the outcome of the examination.
- Patient continues to be hospitalised
- Consultant tells the Houseman to know of the medicine for Patient during Nurse.
- Houseman prepares the prescription (paper) form and passes it to Consultant to sign.
- Consultant checks and signs the prescription form.
- Houseman updates IMR and SCM of the examination outcome and medicine procedure, prepares the discharge summary for Patient and passes IMR and the prescription form to Nurse.
- Nurse informs PSA of Patient's possible discharge
- Nurse passes the prescription form to Porter.
- Porter delivers the prescription form to Pharmacist.
- Pharmacist reads the prescription form.
- Pharmacist prepares medicine, checks the medicine and update the ePharm system.
- Porter receives the medicine, delivers it to Nurse.
- Nurse brings the medicine to Patient and explains about the medication.
- Nurse maintains Patient's health
- Abnormality detected? Yes 20% / No 80%
- Nurse contacts and informs Consultant.
- Consultant reviews Patient case using SCM on Desktop.
- Cancel Discharge? Yes 30% / No 70%
- Nurse informs PSA not to discharge Patient.
- Nurse gives PSA re-confirmation that Patient is to be discharge.
- Nurse performs a discharge summary, explains the discharge summary, explains the medication with Caregiver and helps Patient leave the ward bed.
- Patient is discharged and leaves the ward with Caregiver

- PSA calls Patient's Caregiver to inform possible discharge
- PSA contacts Caregiver to arrange for him to handle the discharge procedure.
- PSA contacts Caregiver to inform cancellation of discharge and apologises.
- Patient continues to be hospitalised
- PSA prepares financial statements for Patient.
- PSA settles the payment and schedules the next appointment, done with Caregiver.

Documents/Systems referenced: IMR, SCM on COW, SCM on Desktop, prescription form, Medicine, ePharm, SAP ERP, Discharge checklist form, Discharge Summary

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6. As-Is static analysis with both RCI and RCR models.

6.1 Root Causes Issues model (RCI)

Process Name: Patient Discharge Homebound (PDH) Process

Issue #	Issue Description	Cause Description	Root Cause	Issue Category	Business Performance Metrics	Impact Level
1	Consultant cannot view X-ray images clearly on SCM on COW.	The laptop screen of SCM on COW is too small, and the colour and resolution of the X-ray images are poor.	Poor hardware quality	System	1. No. of X-ray hardcopies printed for Consultant 2. Time taken to read Patient's record	4
2	Updating of IMR form and keying in the data into SCM is tedious and time-consuming.	After manually updating Patient's IMR, the same data is being re-entered into SCM system which is redundant.	Paper-based System	Process	1. Time taken to update Patient's examination outcome and other information	4
3	Porter needs to do numerous trips to deliver the physical prescription form, which has illegible handwriting. This leads to a waste of time to transport and decipher the form.	The physical prescription form needs to be written and transported manually.	Paper-based system	Process	1. Time to deliver the prescription form to Pharmacist 2. Time taken for Pharmacist to prepare the medicine	5
4	PSA spends a lot of time to call Caregiver about the discharge status and Caregiver is upset if the discharge is cancelled.	The discharge status keeps changing due to multiple rounds of re-examinations.	Wrong activity sequence	Process	1. Number of cancelled discharge cases 2. Time taken for PSA to contact Caregiver	4
5	The time taken to get medicine and explain medication to Patient is wasted if Patient is found to be unsuitable to be discharged in the afternoon.	The discharge status is only confirmed after getting medicine and explaining the medication to Patient.	Wrong activity sequence	Process	1. Cost of rejection paths (Patient is not discharged) 2. Total process time of the PDH process	4

| 6 | PSA takes a long time to settle payment and schedule appointment with Caregiver, causing increased workload for the PSA. | Payment and appointment scheduling have to be done in Hospital | Lack of system for Caregiver | Process | 1. Time taken for PSA to settle payment and schedule appointment. | 3 |

6.2 Root Causes Recommendation model (RCR)

Root Cause	Recommendation	Recommendation Impact Score with reason	Complexity of Implementing Recommendation
Poor hardware quality	1. Computers on Wheel can be upgraded to better computers. 2. X-ray hardcopies should already be printed out before the morning check-up.	**4** Reduce the time taken for Consultant and Houseman to view Patient's health records, which is the common activity regardless of Patient's suitability to be discharged	Low
Paper-based system	1. Digitalise paper IMR forms into SCM 2. Digitalise paper prescription forms into SCM, and integrate SCM with ePharm for transmission of prescription forms.	**5** Eliminates the bottleneck of the PDH process	High
Wrong activity sequence	1. Confirm the discharge status before getting the medicine 2. Explain the medication to both Patient and Caregiver at once when the Caregiver arrives	**4** Reduce the waste of time and resources in the case of discharge cancellation	Low
Lack of system for Caregiver	1. A new portal for Caregiver to settle payment and schedule appointment online. 2. Kiosks for Caregiver to settle payment and schedule appointment by themselves at Hospital	**4** Reduce the workload of PSA and make the process more convenient for Caregiver	High

7. **Signavio Static Analysis of the As-Is business process**

From the Signavio As-Is Static Reports of Cost Calculations and Resource Planning, the weighted total cost of the As-Is PDH process is $74.14; the weighted total time of the process is 120.10 minutes. This means that on average, Patient costs Hospital $74.14 and takes more than two hours in the process per day. The weighted annual cost to Hospital is estimated to be $663,000.

The number of full resources in the As-Is Resource Planning indicates the number of manpower needed for each role to complete his tasks within his working hours. Based on the report, there is a clear shortage of manpower for Consultant and Houseman. The analysis suggests that 5 Consultant and 6 Houseman is needed for the As-is process. However, there are only 2 Consultant and 4 Houseman currently, showing that Consultant and Houseman are likely to work overtime (beyond

11am) to examine all Patient in the morning, or Hospital may have to hire additional Consultant and Houseman for the process.

Based on the Path Analysis, Paths #2 and #4 involve the greatest number of manpower for Consultant (4.49), and Paths #2, #3 and #4 for Houseman (4.56). Even the shortest path, Path #1, still requires 3.87 Consultant and 4.41 Houseman.

As for the cost and execution time, Path Analysis suggests that Path #4 is the costliest and the most time-consuming, with a total of $139.18 and 300 minutes. However, Paths #2 and #3 also cost much money and time as well ($117.18 and 220 minutes, $114.43 and 270 minutes respectively). The cost and time for Path #1 is the lowest as there is only one task after Patient is examined to be unsuitable to be discharged.

Overall, regardless of whether Patient is discharged or not, the As-Is process is costly and time-consuming, and the shortage of manpower for Consultant and Houseman is very severe.

8. <u>Recommendations</u>

No.	Recommendations	Rationales
1	Computers on Wheels will be upgraded to better computers.	The upgrade would make it easier for Consultant and Houseman to view Patient's health records, especially the x-ray images. This thus reduces the time taken for this activity. As COW is used in many other activities, better computers will also improve the efficiency of those activities. The cost on better computers is a one-time purchase cost and thus the additional cost per Patient is negligible in the long run. However, printing of x-ray hardcopies is rather constant and thus higher than the purchase cost in the long run.
2	Digitalise paper IMR forms into SCM	One of the major root cases is paper-based system. Digitalisation eases data entry and update and avoids duplication of such activities.
3	Digitalise paper prescription forms into SCM and integrate SCM with ePharm. This allows for instant transmission of prescription forms to Pharmacist.	The instant transmission of prescription forms to Pharmacist through system integration between SCM and ePharm significantly reduces the workload of the porter. The digitalised prescription form also avoids the problem of illegible handwriting, shortening the time for Pharmacist to read it. Therefore, the bottleneck of the PDH process, which is the medicine preparation process, would be reduced.
4	Confirm the discharge status before getting the medicine.	There is a 6% probability that Patient is not suitable for discharge after receiving the medicine. By confirming discharge status first, the resources spent on medicine preparation process and medication explanation can be saved.
5	Explain the medication to both Patient and Caregiver at once when the Caregiver arrives	This would remove the duplication of medication explanation, thus shorten the total process time.
6	New web portals for Caregiver to settle payment and schedule appointment online.	Considering that the majority prefers online payment and appointment scheduling, the workload of PSA would be reduced significantly. Such mode would also enhance the convenience of payment settlement and appointment scheduling, thus increases the Caregiver's satisfaction. The technology for such web portals are very mature and prevalent in the market, thus involve little risk.

Based on the above 6 recommendations, we propose the implementation of improved technology together with a process flow change as a part of the To-be process.

9. To-be Collaboration Model

Front Desk

PSA

SAP ERP

1. Payment
2. Appointment date

1. Patient information
2. Caregiver information
3. Financial records

1. Appointment date
2. Updated financial records

Patient

Caregiver

Patient

1. Medication explanation

1. Payment
2. Appointment date

1. Medicine
2. Medication explanation
3. Discharge summary

Nurse

Nurse

1. Discharge summary

1. Examination outcome (discharge or not)
2. Prescription draft
3. Discharge summary

Doctor

SCM System on Computer on Wheels

Consultant

Houseman

1. Patient's health records*
2. Prescription draft

1. Signature

1. Verbal prescription details

1. Patient's health records*

1. Prescription

1. Notification of patient's discharge

Pharmacy

EPharm

Pharmacist

Porter

1. Prescription

1. Medicine

1. Medicine

*Patients' health records include test results, conditions and x-rays/MRI/CT scans

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10. To-be scenario/solution, the users involved, resources needed and the IT applications used

10.1 Roles and IT applications involved

Roles/Resources	Short Description
Consultant	Views Patient's health records and examines Patient's conditions; Prescribes medicines verbally and signs prescription forms.
Houseman	Views Patient's health records and examines Patient's conditions with Consultant; Updates Patient's examination outcome and medicine prescribed on IMR using SCM on COW; Types prescription forms; Prepares for Patient's discharge summary.
Nurse	Explains medication to Patient and Caregiver; Performs a final check before Patient leaves the ward.
Patient Service Associate (PSA)	Contacts Caregiver to inform about Patient's discharge; Settles payment and schedules the next appointment.
Porter	Delivers prescribed medicines from Pharmacist to Nurse.
Pharmacist	Prepares and dispenses medicine based on the prescription form.
Caregiver	Settles payment and schedules the next appointment either online or with PSA.
SAP ERP	Information system providing detailed patient information, Caregiver information, patient financial records, patient admission details and patient appointment scheduling; Receives notifications about Patient to be discharged and display them in the notification inbox for PSA to view. E-appointment web portal that allows Caregiver to make appointment online E-payment web portal and integrates with external online banking system to allow Caregiver to make payment online
ePharm	Receives and display prescription forms to Pharmacist; Automatically archives orders to track Patient's drug use.
Sunny Clinical Manager (SCM) System	Proprietary off the shelf information system that can be accessed on both Desktop and COW; Storage and display of Patient's lab tests, x-rays/MRI/CT images; Patient discharge summary preparation function; Prescription form preparation and signing function; Sends notifications and prescription forms to SAP ERP and ePharm respectively automatically; IMR display, update and archive function;

### 10.2 To-Be scenario with resources needed

Activity Step	Previous Step(s)	Activity Description	Time (min)	Role	Resource
1a	-	Consultant reads Patient's records and views his test results, conditions and x-rays/MRI/CT scans on SCM on COW	10	Consultant	SCM on COW

1b	-	Houseman views Patient's records with Consultant	10	Houseman	SCM on COW
2	1a	Consultant examines Patient	10	Consultant	-
3	1b	Houseman examines Patient with Consultant	10	Houseman	-
4a	2, 3	Houseman updates IMR with the outcome of the examination on SCM on COW. Process ends.	2	Houseman	SCM on COW
4b	2, 3	Consultant lets Houseman know of the prescribed medicine	5	Consultant	-
5	4b	Houseman types the prescription form on SCM on COW	3	Houseman	SCM on COW
6	5	Consultant views and signs the prescription form on touchscreen computers	1	Consultant	SCM on COW
7	6	Houseman updates IMR with the outcome of the examination and prepares the discharge summary for Patient on SCM on COW	5	Houseman	SCM on COW
8a	7	A notification about Patient to be discharged is sent to SAP ERP	0	SCM	SAP ERP
8b	7	The prescription form is sent to ePharm	0	SCM	ePharm
9	8a	PSA views the notification about Patient to be discharged on SAP ERP and contacts Caregiver to arrange for him to come	15	PSA	SAP ERP
11	8b	Pharmacist reads the prescription form on ePharm	5	Pharmacist	ePharm
10	9	PSA prepares for the financial statements	30	PSA	SAP ERP
12	11	Pharmacist prepares and checks the medicine, and dispenses the medicine to Porter	12	Pharmacist	-
13	12	Porter receives the medicine and delivers it to the Nurse	10	Porter	-
14a	10, 13	PSA settles the payment and schedules appointments	30	PSA	SAP ERP
14b	10, 13, 14a	Nurse performs a final check with a discharge checklist form, gives the discharge summary and medicine, and explains medication to Caregiver and Patient, and help Patient leave the ward bed to be discharged.	30	Nurse	SCM on COW

To-be PDH Workflow Diagram
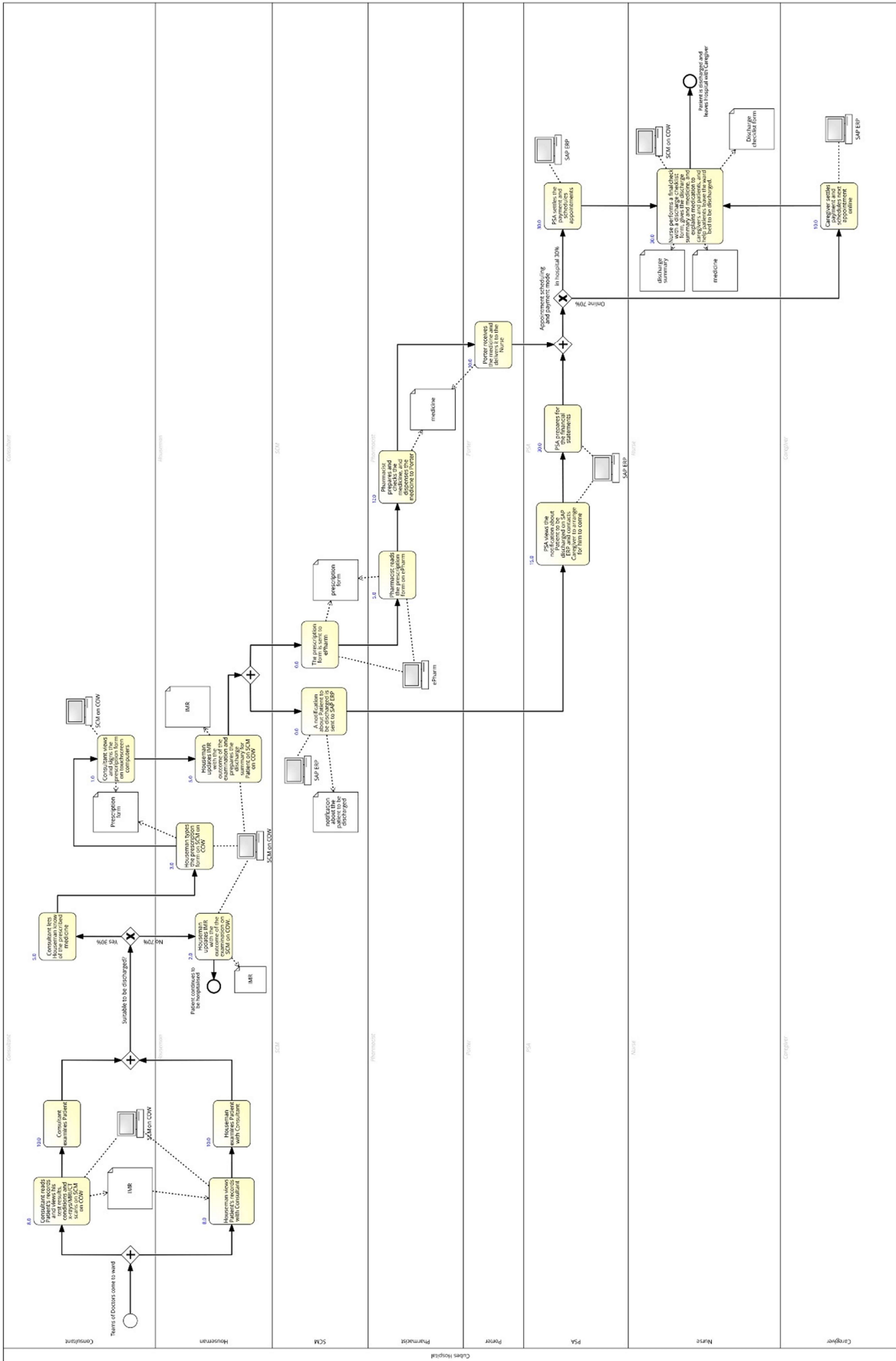
12. Signavio Static Analysis of the To-be business process

Based on the Signavio Static Reports of Cost Calculations and Resource Planning, the weighted total cost of the To-Be PDH process is $48.00 and the weighted total time of the process is 77.00 min. This means that on average, Patient will cost $51.83 to Hospital and take 77 minutes in the process per day. The weighted annual cost to Hospital is estimated to be $420,000.

Based on the To-be Resource Planning report, the To-be process is able to be completed with the current manpower available and within their working hours. The report suggests that only 2.18 units, thus 3 Consultant are needed for the To-be process. However, if the To-be process is implemented, the technical allowance can be reduced in the long run, resulting in the number of resources to be reduced to around 2 units. Thus, the current 2 Consultant will be sufficient for the To-be process. Although the Consultant's working hours are extended to 4 hours, the workload is reduced as there are no afternoon case reviews and they are also paid for the additional hour. Therefore, the extension should not be met with much resistance by Consultant.

The number of Houseman needed for the To-be process is 2.40 units, meaning that the current 4 Housemen are more than sufficient and the ones updating examination outcomes may be able to participate in viewing records and examining Patient as well. The rest of the roles require less than a unit of resources in the To-be process, so they can dedicate more time to other tasks in other processes.

The To-be process introduces two other resources: SCM and Caregiver. Given that SCM's tasks are simply sending notifications and digital prescription forms, which can be performed in milliseconds, the execution time is negligible. The system is always available in the morning as maintenance is done during midnight. Since such tasks require little memory of the system, the number of resources needed is negligible. Despite the 10 minutes execution time of Caregiver for online payment and appointment scheduling, since Caregiver is not the employees of Hospital, the calculations of cost, time and resources required are not in the scope of our discussion and analysis.

Based on the Path Analysis, P#3 is the costliest and the most time-consuming with a total of $85.85 and 182 minutes. There is some improvement in Path #2, given the payment and appointment is done online, with the total cost of $78.35 and execution time of 162 minutes. There is no significant difference between the manpower requirement between Paths #2 and #3.

As Path #1 ends after Patient's unsuitability to be discharged, examination outcomes are updated by Houseman with SCM on COW in the morning, the rest of the roles do not need to perform any tasks. The cost, time and manpower needed are thus zero.

Overall, the current manpower resources are sufficient for the To-be process. Hospital does not need to hire more Consultant or Housemen but to extend their working hours by one hour in the morning.

13. Analysis of the To-be process in comparison with the As-Is process

In the To-be process, the total weighted cost per day has been decreased by 28.65% ($72.64 to $51.83) as compared to the As-Is process. The total weighted time taken for the process per day has also been reduced by 35.89% (120.10 minutes to 77.00 min). As a result, Hospital can save a staggering amount of $209,000 per year.

The As-Is Resource Planning shows that the As-is process requires more resources than what is available. Our To-be process successfully manages to resolve this issue by reducing the number of Consultant and Housemen needed by approximately 50% (4.9 to 2.18 Consultant and 4.41 to 2.40 Houseman). The number of Nurse and PSA needed is also reduced from 0.90 to 0.38 Nurse and 1.08 to 0.75 PSA, which means that their workload would be alleviated. Thus, the Nurse no longer have to multi-task and the PSA do not have to work overtime.

Our To-be process effectively address the root causes in the RCI model. With better computers, the time taken to view Patient's health records by Consultant and Houseman is greatly reduced, by approximately 50% (15 to 8 minutes). Digitalisation of IMR and prescription forms successfully speed up the update of examination outcomes and prescription form preparation by Houseman by around 50% as well. Meanwhile, the digitalised prescription form resolve the issue of illegible handwriting and fasten the medicine preparation process by 40%, shown in Path Analysis.

In the To-be process, the medicine will only be fetched after Patient is confirmed to be discharged in the first check-up. Since the medicine preparation process time is reduced by 40%, the waiting time to get the medicine is greatly shortened. This eliminates the need for a second check-up to reconfirm Patient's conditions are still suitable to be discharged as the conditions are highly likely to be the same as in the first check-up. Hence, the To-be process does not include path #2, path #3 and path #4 of the As-is process. Therefore, the weighted average total time for Patient who are not discharged eventually is reduced by 40.31% and the average total time for Patient who are to be discharged eventually is reduced by 34.88%. Lastly, PSA in our To-be process will only contact Caregiver once when Patient is suitable to be discharged, thus will not need to deal with upset and angry Caregiver when the discharge is cancelled.

Therefore, the To-be process has successfully resolved the issues identified in the RCI model, lowered the time taken, costs and manpower needed for the PDH process.

14. **How the To-be process is of value to the Hospital**

After careful analysis of the existing process and evaluation of possible solutions, our proposed To-be process will improve the efficiency of the PDH process and reduce the cost incurred the greatest.

Our To-be process aligns with Hospital's vision and mission, and considers the concerns of the management regarding costs, technology and efficiency. In the following paragraphs, we will elaborate how our To-be process fulfils the requirements and brings values to Hospital.

Quality Healthcare
Better healthcare facility directly relates to the healthcare quality that is the core value for hospitals. Laptop procurement will provide better resolution for Consultant to view x-rays and thus reduce medical errors. After weighing the relatively high cost of the procurement against its benefits, being better healthcare quality and reuse of the old laptop in other process, we believe that this purchase is necessary given its importance. Besides, the digitalisation of documents such as IMR and prescription form eradicate illegibility issues that might result in serious medical accidents.

Better Relationships Among Departments
The integration of the systems facilitates the collaboration among different departments, thus bringing better relationships among Hospital employees. Digitalisation of IMR and prescription form avoids the problem illegible handwriting and eases the comprehension of information. There will be thus less conflict between different departments, especially between Housemen and Pharmacist.

Better Customer Relations
Caregiver and Patient are the most important customers for hospital. Caregiver are given the freedom in choosing their preferred mode of payment and appointment scheduling. The adoption of the online system caters to the preference of the Caregiver, reduces their waiting time to settle payment and schedule appointment, and makes the process hassle-free. In addition, cases of complaint will be reduced as Caregiver are only notified of confirmed discharge from PSA. For Patient, the accelerated PDH process might save their one day of hospitalisation fee and reduce their waiting time to be discharged at Hospital.

Streamlining PDH Process

Our To-be process has streamlined the PDH process to reduce costs and manpower required. Through digitalization of documents, automated information transmission, online payment, change of event sequence and removal of unnecessary steps, the costs incurred and manpower required for the PDH process is greatly reduced. With better efficiency, hospital can have better bed turnover rate, so that more Patient could be admitted and get quality treatments on time. It aligns with Hospital mission and will in turn result in improved hospital reputation.

Balance Between Costs, Risks and Benefit for Technology
Understanding the management's concerns for costs and risk in the use of technology, we have explored and carefully evaluated the possible solutions to improve its IT infrastructure, in order to maximise the resource utilisation and efficiency. The seamless integration of the three existing systems is cost-effective and reduces the risks of introducing new systems in the data-sensitive hospital environment. The online payment and appointment booking system, being an interface from the SAP systems for Caregiver, makes use of the available online payment methods in the market. Only modifications on the existing systems are required and no major change will be made. At the same time, the benefits of reducing PSA's workload and having high customer satisfaction level outweigh the costs of implements these modifications.

15. **The Concept Solution Blueprint for the proposed To-be process. (i) Use Case, (ii) Function, (iii) Solution Overview, and (iv) Application Model.**

(i) Use Case Model
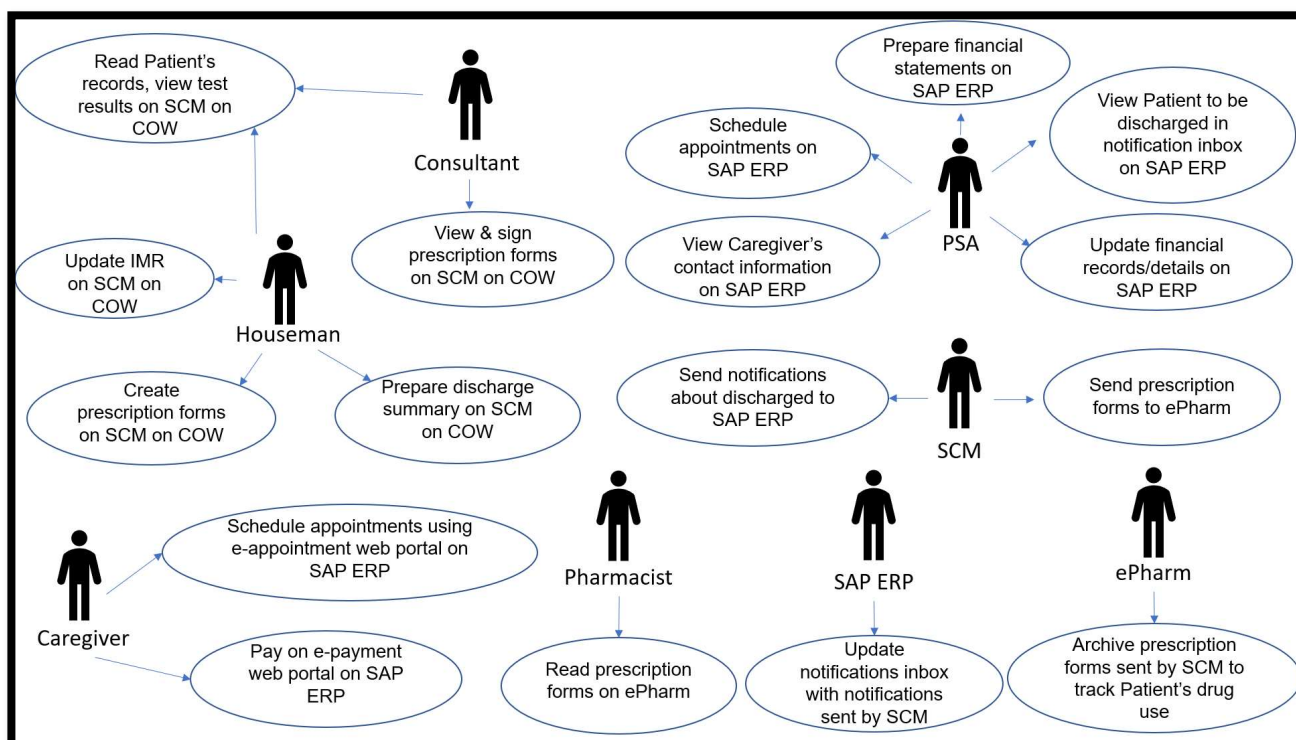
Interactive

Activity	Actor
Read Patient's records, view test results on SCM on COW	Consultant, Houseman
Update IMR in SCM on COW	Houseman
Create prescription forms in SCM on COW	Houseman

View and sign prescription forms on SCM on COW	Consultant
Prepare discharge summary on SCM on COW	Houseman
Read prescription forms on ePharm	Pharmacist
View Patient to be discharged in notification inbox on SAP ERP	PSA
Prepare financial statements on SAP ERP	PSA
View Caregiver's contact information on SAP ERP	PSA
Schedule appointments on SAP ERP	PSA
Update financial records/details on SAP ERP	PSA
Pay on new e-payment web portal on SAP ERP	Caregiver
Schedule appointments on e-appointment web portal on SAP ERP	Caregiver

Automated

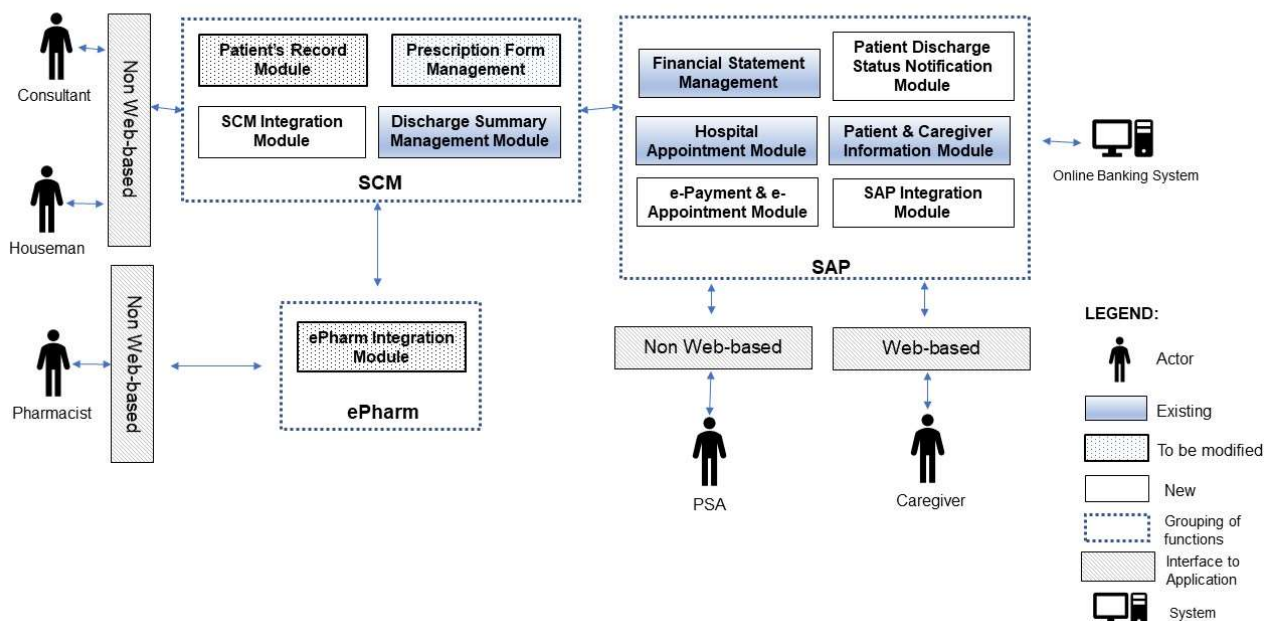| Activity	Send From	Send To
Send notifications about Patient to be discharged to SAP ERP	SCM	SAP
Update notifications inbox with notifications sent by SCM	SAP	SCM
Send prescription forms to ePharm	SCM	ePharm
Archive prescription forms sent by SCM to track Patient's drug use	ePharm	SCM

(ii) Function Model

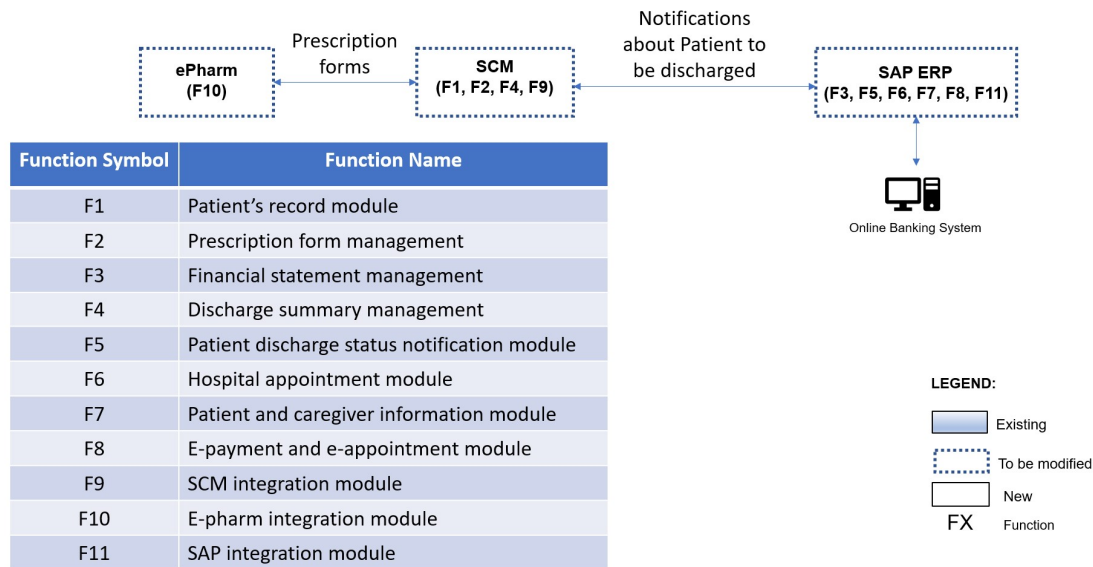| No	Function	Use Case	New/ Existing/ To be modified	System/Comments
1	Patient's record module	Read Patient's records, view test results on SCM	Existing	Need to change hardware, but function is existing
		Update IMR in SCM on COW	New	Currently IMR is in paper form
2	Prescription form management	Create prescription forms on SCM on COW	To be modified	Currently ePharm and SCM have no interface to do this
		View and sign prescription forms on SCM on COW	New	Currently paper prescription form
		Read prescription forms on ePharm	New	Currently paper prescription form
3	Financial statement management	Prepare financial statements on SAP ERP	Existing	
4	Discharge summary management	Prepare discharge summary on SCM on COW	Existing	

5	Patient discharge status notification module	View Patient to be discharged in the notification inbox on SAP ERP	New	Currently SAP ERP does not have this function
6	Hospital appointment module	Schedule appointments on SAP ERP	Existing	
7	Patient and Caregiver information module	View Caregiver's contact information on SAP ERP	Existing	
		Update financial records/details on SAP ERP	Existing	
8	e-Payment and e-Appointment module	Pay on new e-payment portal on SAP ERP	New	New e-payment web portal integrated with external online banking system
		Schedules appointments on e-appointment web portal on SAP ERP	New	New e-appointment web portal
9	SCM Integration Module	Send prescription forms to ePharm	New	Currently paper prescription form
		Send notifications about Patient to be discharged to SAP ERP	New	Currently SAP ERP does not have this function
10	ePharm Integration Module	Archive prescription forms sent by SCM to track Patient's drug use	To be modified	Currently interactive use case where the Pharmacist manually updates ePharm and archives the information
11	SAP Integration Module	Update notification inbox with notifications sent by SCM	New	Currently SAP ERP does not have this function

(iii) Solution Overview Mode

Solution Overview Model

iv) Application model

Function Symbol	Function Name
F1	Patient's record module
F2	Prescription form management
F3	Financial statement management
F4	Discharge summary management
F5	Patient discharge status notification module
F6	Hospital appointment module
F7	Patient and caregiver information module
F8	E-payment and e-appointment module
F9	SCM integration module
F10	E-pharm integration module
F11	SAP integration module

LEGEND:

- Existing
- To be modified
- New
- FX   Function

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16. **Proposal justification and conclusion to tie the company's performance targets with the proposed To-be process**

No.	Performance Targets	Performance in To-be Process
1	Reduce the average time of the PDH process by 30%.	The average time of the PDH process is reduced by 35.89%.
2	Reduce the average cost per patient in the PDH process by 30%.	The average cost per patient in the PDH process is reduced by 28.65%.
3	Reduce the average time of the morning check-up process by at least 20%.	The average time of the morning check-up process is reduced by 32.2%.
4	Reduce the bottleneck of the PDH process, which is the medicine preparation process, by 20%.	The medicine preparation average process time is reduced by 40%.
5	Reduce manual activities with the use of automation by at least 2 activities	1) Manual activities are reduced by 5 activities. 2) There are 2 additional automated activities
6	Reduce the average time of the Caregiver settlement process by at least 20%.	1) Reduce the time taken for contacting Caregiver by 55.4% and for payment by 15.2%. Thus, the average time taken for the Caregiver settlement process is reduced by 31.6%.

Our proposed To-be process has carefully considered the management's concerns and evaluated each recommendation's risks, costs and benefits. With our recommendations, there are significant improvements in the PDH process with all performance targets either almost met or even exceeded. With a large amount of $209,000 saved per year, an annual cost of approximately $135,000 for system integration and web portal development and maintenance, and a one-time cost of $1,410 to purchase better computers for COW (see appendix for the cost estimation) for the To-be process is justifiable. Moreover, with higher bed turnover rate and better customer relations, it is promising for Hospital to generate a higher profit in the future. In conclusion, our To-be process effectively addresses the root causes of the As-is process using technological solutions with justifiable costs and benefits.

Appendix A: Cost Estimation of Technological Solution

Technological Solution	Estimated Total Cost	References
Online payment and online appointment web portal	Approx. $35,000 per year	https://www.invoiceinfo.com/wp-content/uploads/2017/08/02_2015_Vendor_Self_Service_Portal.pdf https://hackernoon.com/how-to-estimate-what-you-cant-predict-web-app-development-cost-71076c579b3f
2 touch-screen, high resolution laptops	$1,410 (one-time cost)	https://www.lifewire.com/best-touchscreen-laptops-4134190
Integrate existing systems	Approx. $100,000 per year	https://www.explorewms.com/how-much-wms-software-costs-and-how-to-set-your-budget.html