DEVELOPMENT OF MINIMUM CLINICAL DATA SET FOR MASTER PATIENT INDEX FOR SRI LANKAN CONTEXT

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ABSTRACT

Introduction

A Master Patient Index(MPI) is a centralized index of all patients in a health care system. This index is composed of a unique identifier for each patient linked to his/her demographic data and clinical encounters. An MPI is essential to ensure data interoperability in different health care institutions. The development of a Minimum Clinical Data Set is a part of the MPI development ability to exchange data among the health information systems & focused on developing the prototype MPI for Sri Lanka with the view to implementing and scaling up at the national level.

Methods

Phase 1: requirement analysis using focus group discussions (FGD) with information system users. Phase 2: identification of the minimum clinical data set suitable Phase 3 & 4- Application Programming interface (API) model, development of the prototype MPI.

Results

FGD conducted in 6 hospitals.78 interviewers. They highlighted the key requirements for the MPI. Which were the unique identification method and different searching criteria and merging records to avoid duplication. Interview of the different specialists in the relevant clinical fields identifies the minimum clinical dataset. Using this information, the requirements specification for Minimum Clinical data set and MPI was developed. A combination of mono lithic and micro services architecture was selected to develop the MPI. The API using the Personal Health Number (PHN) as the unique patient identifier and HL7 standard was developed and implemented.

Conclusions

Development and implementation of an MPI have facilitated the long due need for interoperability among health information systems in Sri Lankan.

KEYWORDS

Master Patient Index(MPI), Interoperability, Minimum Clinical Data Set, Personal Health Number (PHN), HL7/FHIR.

1. INTRODUCTION

1.1. Interoperability

“The ability of two or more systems or components to interchange information and use predictably the information that has been exchanged”(1). Interoperability means the ability to communicate and exchange data accurately, effectively, securely and consistently with different information systems, Software application and networks in various settings and exchange data such that clinical or operational purpose and meaning of meaning of the data are preserved and unaltered(1). Some do work with interoperability within a hospital or clinic or from one department, such as the emergency department to another. Interoperability archived through HL7 and XML basically. Health Level 7 (HL7) is an organization that develops and defines standards to facilitate communication between systems and applications are linked to the health area(2).XML is a software and hardware independent tool for transporting data and storing data. For the semantic interoperability XML is extensively used. For the interoperable system this above two methods, HL7 and XML activity take part in exchanging data with other systems.(3)

1.2. Master Patient Index

A Master Patient Index (MPI) is an electronic medical database that holds information on every patient registered at a healthcare organization. It also includes data on physicians, other medical staff, and facility employees. Master patient index is a database that is used all over the world in healthcare organization maintains consistent, accurate and current demographic and essential medical data of the patients seen and managed within its various departments(4). The patient is assigned a unique identifier that is used to refer to this patient across the enterprise. MPI is a form of customer data integration which is implemented by Healthcare organizations for identify, duplicate, match, and cleanse and merge patient records. After creating a MPI and implementing will used to obtain a complete and single view of a patients. “The MPI create a unique identifier (UI) for each and every patient and maintain it with the mapping to the identifiers used in each record’s respective system”(5) Health Information system is marching diligently toward a more connected system of care through the use of EHRs and electronic exchange of patient information between hospitals(6). The Patient Identification and matching are focused on to help ensure the accuracy of every patient’s data and the availability of their information wherever and whenever care is needed(7). From the respective systems, MPI provides an Application Programming Interface (API) for querying and searching the MPI to find patients and the ways or the pointers to their identifiers and records. Also, store some subset of the attributes and data for the patient so that it may be queried as an authoritative source of the "single most accurate record" or "source of truth" for the patient(4). Registration or other practice management applications may interact with the index when admitting new patients to have the single best record from the start or may have the records indexed at a later time. Application programming interfaces make it easier for developers to use certain technologies in building applications for the interoperability of health information systems. By abstracting the underlying implementation and only exposing objects or actions the developer needs, an API reduces the cognitive load on a programmer. Reduction of cognitive load increases the functionality of the programmer’s program to overcome defeats like bugs. While a graphical interface for clients might provide a useful with a button that performs all the steps for fetching and highlighting new contents, an API for file input/output might give the developer a function that copies a file from one location to another location.

1.3. Minimum Clinical Dataset (MCDS)

Minimum clinical dataset (MCDS) or the Minimum data set(MDS) is an important topic in healthcare information exchange platforms. There is no clear unified definition to MDS and this is poorly defined during the past few decades. The following definition is made for MDS. MDS is a coherent set of explicitly defined data elements in health care (5). MCDS is first introduced in the United State of America as the federally mandated process by the federal government for clinical assessment of all residents in health care. Commonly for Developing Minimum Clinical Datasets developer used consultants in different filled. While doing the discussion among these expert developers have to read through the literature reviews of former implementations and collect the existing clinical data set(6).

Figure 1. Publications by Minimum Dataset Clinical Specialty

In August 2012 Sarvesh Jain (7) developed a prototype for Health Master Person Indexfor public use, he designed a detail architectural design to solve the problem with related to the patient data sharing in the different domain system. Integration infrastructure will provide the best software solution for interoperability of health information systems.

This integrated health information system improves health data sharing and provides better health services to the patient by connecting multiple isolated health domains to external systems. During the prototype, development developer tried to minimize the duplication and introduce a solution for a unique identification method. If there are several different first names of a pediatric patient, the merging application will merge simply all of them. This merging method called as stacking(8).

Some other MPI mergers determine the best accurate and mostly used scenarios. Also giving the chance for the manual record filtering using the expert on the filled. Intergraded systems much useful for the better healthcare but in some occasion, there was some adverse effect with these systems in 2004 Dr. J.T Finnell (9) published in his publication mentioned about the adverse effect following the mistreatment at the emergency departments.

The patient comes with feature suggestive of anterior lateral STEMI to the emergency department that needs thrombolization with thrombolytic. Treating patient doctor gone through the system and find the patient is treated for an intracranial hemorrhage(ICH) very recently. So, the doctor's conclusion was that with the thrombolytic treatment patient may start bleeding intracranial again. He suggested not to thrombolysis and going for the interventional treatment. That treatment method is very expensive so the patient has to pay an extra amount of money in his old age. But after the intervention doctor gets to know that this patient was not treated for any ICH previously. This all due to the duplication of record in the system.

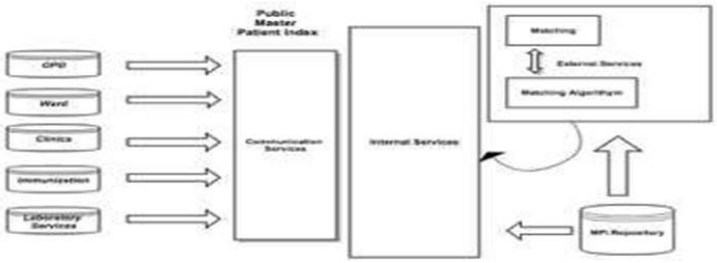

Figure 2. Development Methodology for Minimum Clinical Dataset Piper Svensson Ranallo And Terrence J. Adam

1.4. Sri Lankan Health Care Setting

Government health care system has several service deliveries, such as administration, training, curative care, public health, other resource management programs (9). In Sri Lanka, curative care is the Hospitals mainly categorized into several levels according to resources allocation and resource availability to the institutions. Some of them belong to the line ministry. Line ministry is the central core or the backbone of the health ministry. The Hospital that attached to the line ministry are the teaching hospitals, provincial general and district general hospitals, especial care unit like cancer institution and the rehabilitation units. Other hospitals are attached to the provincial council under the provincial health ministry. Inside the curative sector, there is a referral order from the lower level of curative care (primary care institutions) to the upper level (tertiary care institutions). It is important to maintain the sustainability of this system to provide better care for the bath paediatric population and the adult population without time delays and lags. The public sector provides 95%of inpatient care while private sector responsible for remaining 5%. However, this referral system does not prevent from directly going to private practices by consultants and general practitioners as well as admission to private hospitals(8) .

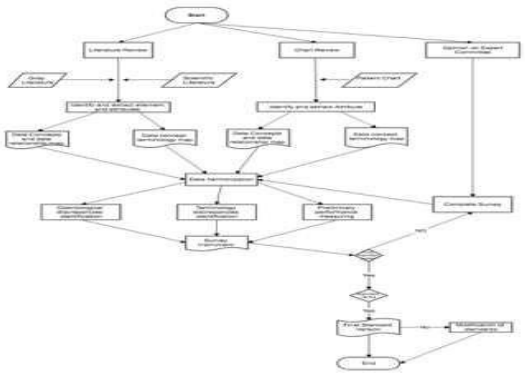

Figure 3. Development Methodology for Minimum Clinical Dataset by Piper Svensson Ranallo And Terrence J. Adam

1.5. Interoperability of Health Information Systems in Sri Lankan Contest.

Sri Lanka is a developing country, which is establishing towards to the using of the technology of the new era. Comparative to other developing countries the science and technology is passed to Sri Lanka simultaneous with the western countries. With the globalization and free trading environment in Sri Lanka open the door to the western world to trade their science and technical products through the country. The low-cost product supports a lot to grow the enthusiasm on the

people to fall on the track with the westerners where they used in day to day life. Electronic Medical Records systems (EMR) work as a standalone application in Sri Lanka. Government hospitals are established with HIMS/HHIMS (health Information management systems/Hospital health Information management systems) which is developed by a Sri Lankan software vendor ICTA (Information and Communication Technology Agency). At this moment, functioning of HHIMS/HIMS in the hospital without any interaction with the other existing electronic health record system. The interoperability among the systems is not established. To overcome this issue, the government should plan to develop some application that could overcome the interoperability issues. Developing a MPI is the 1st step towards the interoperability of among standalone systems. By correctly matching patient records from disparate systems and different organizations, a complete view of patient records may help for the continuation of patient care. With this complete view, numerous benefits may be realized including a better patient care and continuation of the patient care pathway. Improved customer service can have offered with reduced waiting time at hospitals clinics and Outpatient department (OPD). In an emergency or other critical care situations, medical staff more confident that they know medical conditions or other health related information that would be critical to providing proper care. Past medical history, past surgical history and clinical care related information, can be obtained from across organizations (12). Blood group and essential minimal clinical data will provide unconscious patient to be live after 5 hrs. other than death without intervention. Need for a MPI in Sri Lankan context is that to bridge the gap between interoperability issues among the HHIMS/HIMS in Sri Lanka. MPI will establish the continuation of care pathway by multiple health care providers. Enable exchange of minimum essential data set among different EMR systems for the Sri Lanka. In continuation of care pathway or other critical care situations, medical staff can be more confident that they know medical conditions or other information that would be critical to providing proper care. Retrieval of past medical history, allergy history. Family history from multiple EMRs to the EMR at current care provider.

1.6. Objectives

1.6.1. General Objective

Developing the minimum clinical dataset for the Master Patient Index (MPI) for Interoperability of ehealth Systems in Sri Lanka.

1.6.2. Specific objectives

1. To propose suitable Minimum Clinical Dataset for proposed MPI
2. To Identifying and suggest solution for EMR interoperability through a MPI. This including developing A high-level software architecture of MPI and formulate Functional Requirements for a MPI.
3. To suggest essential message template for MPI

2. METHODS

2.1. Action Design Research (ADR)

For information system development has two basic missions to complete to achieve the successful product and implementation.1st mission is contribution to the theoretical aspect of the research and 2 nd aspect is how to show the problems of the system using the current practices. For system development and implementation, the action research(AR) and the design research(DR) methods

being used. In the design research, the new design is developed and the action research solves an immediate organizational problem. To make a product as successful one researcher has to put the theory into practice in a practical way. The design research and the action research work in a similar way. Designing the master patient index is a DR and the implementation in the health care setting is an AR. ADR method "IT artifact is built and evaluate in an organizational setting using a general prescriptive design" (10). The research project is a qualitative research. I used action design research(ADR) as the method for development of the MPI. ADR method "IT artifact is built and evaluate in an organizational setting using a general prescriptive design" (10). This deals with 3 main areas of the IT artifact development. 1st problem formulation process using the design research (DR) method .2nd Evaluation using DR method. 3rd and final are the artifact building. As according to the ADR method research project is carried out in 4 phases. In the phase 1 problem formulation done. Phase 2 identification of minimal clinical data set for the interoperability Phase 3 building, intervention and evaluation process for the MPI Architecture.. At the final phase developing the system after formalization of what learn from the previous phases. In the phase 1 and 2 data collection using focus groups, discussion and analysis of its result will be done in order to identify data elements and user requirements of MPI prototype and the minimal clinical data set. Phase 3 involves in identify the suitable API model for the proposed MPI. Phase 4 is developing a prototype MPI using the identified user requirements.

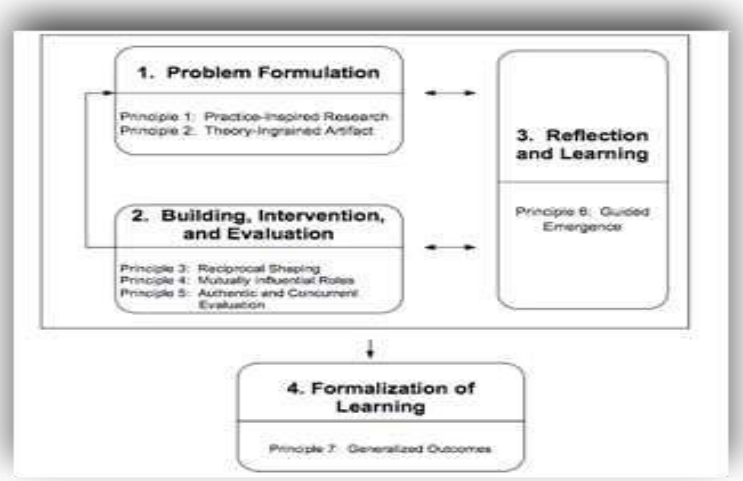

Figure 4. ADR Method - Stages and Principles(10)

2.2. Phase 1

In the phase 1 did the problem formulation. During this phase practical, inspired research principal used. In this phase viewing the field problem and knowledge gathering and creating opportunities is the main target. Opportunity is the intersection of technical and organizational domains. Action design researcher will get the knowledge to apply to set of problems to solve the problem

This was carried out using Qualitative research design. Formative evaluation be applied to the qualitative research design. The research did on the staff members who are involved in the use of the HHIMS/HIMS health information system in the relevant respective hospital of two districts (Colombo and Kalutara). The sampling method is Convenient sampling method is chosen mainly

because of the limited resources and time. Study instruments Semi-Structured interviews for HHIMS/HIMS users. Focus group discussions and interviews with, HHIMS/HIMS users and Software Development group team. Interviews and Focus group discussion (FGD) conducted by the principal investigator with the help of supervisors. Data recording was done correctly. Randomly selection of participants/groups for FGD was done. FGD was done following an unstructured interview at the beginning, and then semi-structured questions was created to ask later by avoiding the unimportant issues arrived at the earlier conversation. After taking permission from the relevant authorities the principal investigator introduced himself to the staff at the above relevant respective hospital of Colombo and Kalutara district and explain the research and the methodology to the eligible participants of the research. Informed consent was obtained from the eligible participants after explaining the full investigation procedure including benefits and risks. An adequate time allowed for them to clarify any query or further questions. Informing them that they can withdraw from the study at any time without giving any reason and no further correspondence made ensures voluntary participation. Data from interviews analyzed using qualitative methods to find relevant concepts related to the development of MPI. Collected ideas recorded using computer software. These recoded data used to identify themes, Concepts, requirements of the users (11). Research did not involve collecting personal identification information of participants during data collection. Therefore, privacy and confidentiality of the participants are preserved. Ethical approval has taken by ethics review committee PGIM, University of Colombo. Before collecting data from health institutions necessary permission gained from the head of the institutes. Privacy, security, and confidentiality of data assured. The purpose of the research and publication would not involve using any personally identifiable data of anybody or there is no possible access the system or its data by third parties because all data gathering would be done by researcher's personal computer.

2.3. Phase 3

This was carried out using Qualitative research design. Formative evaluation be applied to the qualitative research design. The research did on the Specialist in the four main clinical fields the relevant respective hospital of two districts (Colombo and Kalutara). The sampling method is Convenient sampling method is chosen mainly because of the limited resources and time. Study instruments Semi-Structured interviews for HHIMS/HIMS users. Interviews conducted by the principal investigator with the help of supervisors. Data recording was done correctly. Unstructured interview at the beginning, and then semi-structured questions was created to ask later by avoiding the unimportant issues arrived at the earlier conversation. Informed consent was obtained from the eligible participants after explaining the full investigation procedure including benefits and risks. An adequate time allowed for them to clarify any query or further questions. Informing them that they can withdraw from the study at any time without giving any reason and no further correspondence made ensures voluntary participation. Data from interviews analyzed using qualitative methods to find relevant concepts related to the development of minimal clinical data set. Collected ideas recorded using computer software. These recoded data used to identify themes, Concepts, requirements of the users. Research did not involve collecting personal identification information of participants during data collection. Therefore, privacy and confidentiality of the participants are preserved. Ethical approval has taken by ethics review committee PGIM, University of Colombo. Before collecting data from health institutions necessary permission gained from the head of the institutes. Privacy, security, and confidentiality of data assured. The purpose of the research and publication would not involve using any personally identifiable data of anybody or there is no possible access the system or its data by third parties because all data gathering would be done by researcher's personal computer.

2.4. Phase 3

This phase included designing cycle of the IT artifact. For the development MPI design its architecture was built in this phase of the development of the MPI. Using the both domain of expertise gets together and worked out for a plan for an architectural design of the MPI. Three basic principles used in the development of the architectural design. The 1st did building of the architectural design. After the building of the design intervention made whether that is suitable for used. Evaluation was carried out at the end. The literature review of existing systems used as the tool for the evaluation. Early design process created the Alpha-version of the MPI Architecture. After a thorough literature review and the discussion with the development team, the beta version of the designed. During the period of evaluations through the literature reviews API model for the proposed MPI was identified. Researcher identified the core interaction and message types between electronic health record and master patient index. Devised a mechanism to incorporate unique identification number to MPI 2.4

Phase 4 After identifying the Architectural design and the set of APIs and the core interactions and message type architecture of the MPI the phase 3, Software Development life cycle started following Scrum software development practice. Scrum is an agile software development approach which delivered software programme deliverables at end a software development phase. This procedure is well known among the young software developers who used to develop web based programmes. Complete the MPI development.

3. RESULTS

3.1. Requirement Analysis

During the phase 1 researcher identified what are the system requirement for the development of MPI. The functional and non-function requirement identified then the document developed for the developer use. FGD were conducted in 6 hospitals. There were 78 interviewers (Male -36, and female - 42). They highlighted the key requirements for the MPI. Which were the unique identification method and different searching criteria. All the interviewers were agreed about the unique identification number. During the discussions, the new concept of PHN introduced them and all were 100% agreed and excepted that the PHN is good method as a unique identifier for the MPI. 56 HHIMS users as percentage 71% of the interviewers agreed using of biometrics for the as searching criteria MPI. Some proposed fingerprint as biometric which is well used in the government offices and that would be a good form of method to identify unconscious patient. Some were suggesting facial recognition as searching criteria. 8 persons as percentage 10% were completely disagreed the biometrics. By their own words “biometrics will violate patient privacy not need at the moment”, “you should arrange some backend communication from the software for the future use of biometrics”. Some were not concern about biometrics at all.

All agree with good security and backup needed for the MPI. Breaching security measure affect the patient health care continuity. So, the good security protocols were concern irrespective of the cost. During the computer server failures, few suggest keeping all the data in the MPI will be a best option till full recovery. The health information system administrators were concerned about the introduction of cloud service to the MPI, so the server failure will support. Duplication consider as the main topic that affect the clinical judgment. One doctor who handled the system for long duration brainstorm me with following facts which I have not think at all, he said that there is an option to save the previous drug prescription in the system and can reproduced it in a single click if wrong bar code or duplication can affect prescription and also allergies are visualized in red colour pop up message so the doctor no need to asked for allergic history again and can prescribe allergic drug to patient. To avoid duplication suggested to merge the records using domain experts. Guardian assign for the children as well as for the mentally unsound

patients and unconscious patient were considered by some interviewers. One interviewer suggested giving PHN to every live birth will reduce the back lock. Some suggested that verification of demographic data through population registry will be used full in future. Use of passport number for the PHN generation was consider for foreign patients. Elderly number is considered as a suggestion for searching criteria as well as for PHN generation. 11 HHIMS users as percentage 14% users agreed with the anonymity for the patients. Some says that "in free health, seeking of anonymity do not happen", one senior doctor said "In my 21 year of my service I have worked in different place and I have never seen a patient who seek anonymity but they seek for privacy and confidentiality", one postgraduate diploma holder who had worked at STD clinic for several years said "In central STD clinic patients were given a card with a number that does not have any demographic data even not mentioned as STD clinic, all the investigation and drug are issued for that number". But he also motioned that loss of the card is very common and duplication is common. He mentioned another scenario commonly happen, who were positive for VDRL and waiting to travel to middle east will come and give the history to the doctor and another person will carry the card and go to the lab and give the blood. The patient will get a negative result. He suggested if the is some form of identification method to prevent this happening. Some suggested "only provide if somebody asked for anonymity". In hospitals patients are coming with someone else bar code and take treatment. If any kind of a personal identification method were established in the system missed use of bar code never happen. Also, one person mentioned never violate Hippocratic Orth. Administrator said, "by the constitution given the right to any citizen in the country to seek free health, please do not violate that right by introducing any unethical things". One other administrator said government should provide sufficient fund to laminate the PHN card given to the patient, because the barcode print that now using is not durable.

3.2. MPI Architecture

After the completion of the phase 1, researcher learned the system requirement and started the designing phase of the architecture of MPI. During the discussion with the developers the 1st design architecture formulated. Monolithic type architecture is introduced as the 1st version of the MPI Architecture. If MPI developed on this architecture will be like a web application and problem was that the authentication of MPI and clinical repository on the same deployment version. When the outside requests are exceeding the limit, application will crash. 1 st architecture is based on the monolithic service architecture and it will give the vendor a fast performance, but the authentication and other request are in the same application, when the 5000odd request come to the application from that of 5000-odd request the more than 90% request will be for the authentication. If developer available to remove the authentication part to a separate module to work, then we can get rid of above mention technical difficulties(18) . During the completion of the version 1 of the MPI came a conclusion that when considering above all the problems to introduce the Oath-Server to the system. Oath-Server work as a following in the figure. By introduction of the OAuth server protocol increases the productivity of the MPI solution architecture. Oath server check the credibility of the authorization module feed back to the other services available processed(19). By using an Oath-server reduce the separate logging twice to the systems when the in HHIMS logging to MPI to search for the clinical repository later. So, time consume for the separate authentication will increases the waiting time for the patient. After the discussion with software developing team version 2 of the MPI architecture developed. This development is continuation of the same previous architecture. At the end of the discussion of 1 st Architecture, introduced the Oath– server separately to the system design. During further discussion, the beta version introduced with more secured design. During the all discussions, the security was the utmost important thing is that the researcher learned. By adding the Oath – server to the architecture upgraded the system functionality by securing the data that

restricting the unauthorized trans access. This architecture basically developed using the both monolithic and micro service Architectures

3.3. Minimum Clinical Data Set Development

A Health Care Encounter represents a healthcare recipient care event, which involves a Health Care Provider. The Health Care Encounter is the construct through which all recorded client care activities are identified. Encounters occur to address Health Concerns, and may also address known Health Conditions as well. Health Care Encounter Output represents the results of the event. Currently, MPI will capture only outputs that are provided by Health Care Providers, such as a diagnosis that identifies a Health Condition, a clinical procedure, a service being provided, or a requisition for a diagnostic procedure, medication, referral, medical device, or health care services. An encounter may occur at a geographic or virtual address and it may also be temporary clinic/service area (e.g. outreach clinic), mobile location (e.g., ambulance, mobile lab), or in the field (e.g. disaster location, accident site). The following dataset of healthcare recipients' demographic data shall be transmitted to the MPI when he/she is registered with the healthcare system as a new healthcare recipient or when any of the data elements of the demographic dataset is updated.

Minimal Clinical Data Category	**Data element**
Healthcare recipient demographic data (Minimal dataset)	Personal Health Number (PHN)
	National Identity type
	National Identity (Ex. National Identity card number/ SLIN/ National Digital Identity)
	Reporting name
	Legal Name / Registered Name
	Date of Birth
	Is the date of birth calculated
	Gender
	Contact Details
Healthcare encounter output	Healthcare Institution Number (HIN)
	Encounter identifier
	Healthcare Institution Name
	Encounter type
	Date and Time of the encounter
	Provider identifier (individual)
	Reason for encounter
	Diagnosis (Current encounter)
Allergies & adverse reactions	Allergen name
	Manifestation
Past Medical History	Condition
	Onset
	Clinical Status

Regular Medication	Regular Medication Name
	Regular Medication form
	Regular Medication Dosage
	Regular Medication Route
	Medication Status
Past Surgical History	Procedure name
	Date
Immunizations	Vaccine name
	Date
Obstetric summary	Gravidity
	Mode of Delivery
	Pregnancy outcome
Behavioral Risk factors	Risk factor name
	Risk factor status
	Duration
	Status recorded Date
Health risk assessment	Health risk assessment type
	Risk Assessment Outcome
	Assessment Date
Investigation request	Investigation request identifier
	Name of the investigation
Prescription	Prescription ID
	Medication Name
	Medication form
	Dosage
	Route
	Duration of supply
	Prescription Validity Period
	Prescription ID

Follow-up care plan	Follow-up care plan identifier
	Follow-up care plan author/ institution
	Follow-up care plan category
	Follow-up care plan Description

Laboratory test result	Date and Time
	HIN - Health Institution Number
	Investigation request identifier
	Personal Health Number (PHN)
	Test Name
	Test Result
	Test authorizing Provider ID

Imaging examination results	Date and Time
	HIN - Health Institution Number
	Investigation request identifier
	Personal Health Number (PHN)
	Radiology test name
	Radiology test Impression
	Radiology Test diagnosis /Conclusion
	Provider ID

Medication administration	Personal Health Number (PHN)
	Medication Name
	Medication form
	Dosage
	Route
	Number of doses administered

Procedure	Personal Health Number (PHN)
	Provider ID
	Procedure name
	Indication
	Operative note
	Medical device
	Date and Time
Medication dispensing	Pharmacy ID
	Personal Health Number (PHN)
	Prescription ID
	Prescription issued Healthcare Institution Number (HIN)
	Dispensed Medication Name
	Dispensed Medication form
	Quantity Dispensed
	Date and time

Discharge summary consisting of the following minimal data set shall be transmitted to the MPI on discharge

Minimal Data set	**Data element**
Healthcare recipient demographic data	See above
Discharge Diagnosis/ Diagnoses	Diagnosis text
	Diagnosis code (ICD10 code)
Allergies and Adverse Reactions	See above
Past Medical History	See above
Past surgical History	See above
Regular Medication	See above
Obstetric summary	See above (only for females if relevant/ and the current reason for admission)
Immunizations	See above (Only if directly related to the current reason for admission)
Behavioral Risk factors	See above (if no risk factors shall indicate that)
Health risk assessment	See above
Physical Examination findings	shall record all significant positive and negative findings directly relevant to the current reason for admission

Laboratory test result	See above (shall record if no laboratory tests were done)
Imaging examination results	See above (shall record if no imaging examinations were done)
Medicine	See above. Details about medication, vaccine or other therapeutic/prescribable items which were administered to the healthcare recipient during this admission
Procedure	Details about therapeutic or diagnostic procedures or operations performed which will be needed for the health care professionals participating in current and future care. See above for more details.
Prescription	See above (shall indicate if a prescription was not issued)

3.4. MPI Architecture

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1st architecture is based on the monolithic service architecture and it will give the vendor a fast performance but the authentication and other request are in the same application, when the 5000-odd request come to the application from that of 5000-odd request the more than 90% request will be for the authentication. If developer available to remove the authentication part to a separate module to work then we can get rid of above mention technical difficulties.

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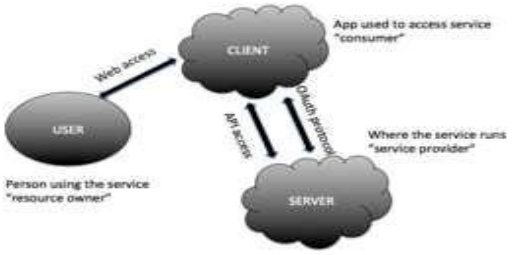

Figure 5 Oath Server
Source - https://oauth.net

By introduction of the OAuth server protocol increases the productivity of the MPI solution architecture. Oath server check the credibility of the authorization module feed back to the other services available processed. By using an Oath-server reduce the separate logging twice to the

systems when the in HHIMS logging to MPI to search for the clinical repository later. So, time consume for the separate authentication will increases the waiting time for the patient.

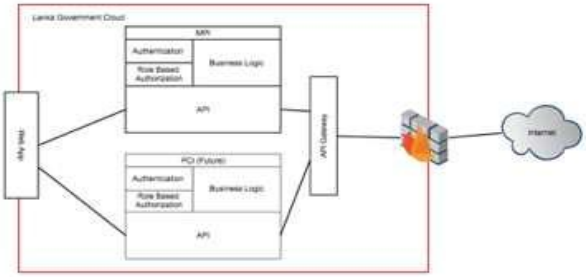

Figure 6. Alpha Version of The MPI Architecture

After the discussion with software developing team version 2 of the MPI architecture developed. This development is continuation of the same previous architecture. At the end of the discussion of 1st Architecture, introduced the Oath–server separately to the system design. During further discussion, the beta version introduced with more secured design. During the all discussions, the security was the utmost important thing is that the researcher learned. By adding the Oath – server to the architecture upgraded the system functionality by securing the data that restricting the unauthorized trans access. This architecture basically developed using the both monolithic and micro service Architectures.

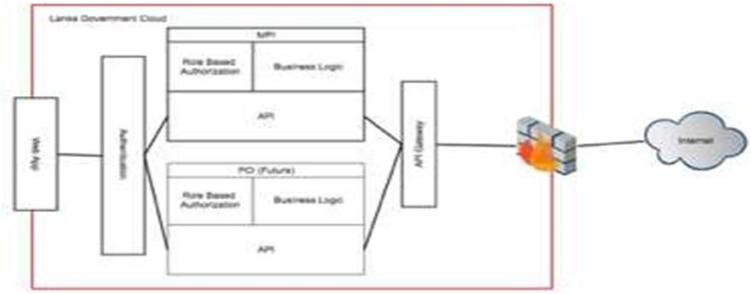

Figure 7. Beta Version of The MPI Architecture

At the last version of the expanded MPI architecture is formulate for the purpose of the future public use with developing the mobile application which can be connected via API to the personal health data after dual authentication.

Researcher learned details about the procedure of the scrum and what is important and why is suitable for this developing this MPI. Use case diagrams formed for the better understanding of the MPI development.

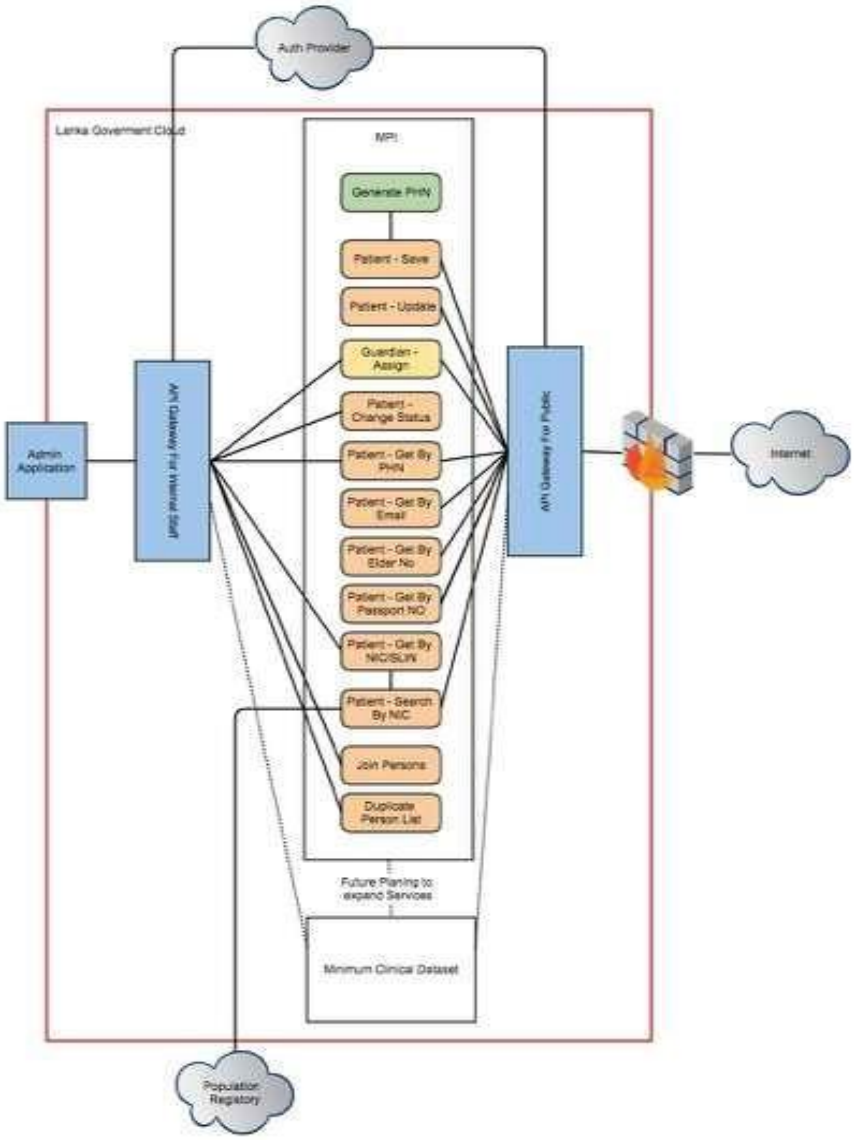

Figure 8. MPI Architecture Final Version

4. DISCUSSION

According to the classification of the Angelo Rossi the computer based clinical data handling follows under the branch of semantic interoperability and to make the continuation of care the semantic interoperability should be maintained. Health data printed on the paper and displayed as the layout –based presentation. In that format health data will be saved in a repository but that will not be useful unless some person searches it. So, the clinical correlation is needed. So, the next step is present health data in a way that correlate with the clinical finding like a health care aware presentation. There are multiple ways that the data could be search for the repositories. With the interoperability and interconnection among the systems will create multiple ways to search the health data through the same institution or different institutions. Using the standard and guild lines will enable the data flow more smoothly while the technical and process interoperability will follow the path. At the end update of the existing data and the newly generated data will be in the system. MPI is the 1st step of the interoperability in HHIMS/HIMS

in Sri Lanka and continuation of care pathway by multiple care providers. Enable exchange of minimum essential data set among different HHIMS/HIMS systems for Sri Lanka. With the introduction of PHN will integrated the LIS, PACS, Citizen mobile application to the public access. After development of MPI prototype was implemented for national use. PHN link with all the available system in the health domain. Expand can done through private sector by providing the API publications. This MPI version is the early version main need to refine the things with the later versions. As this is a new thing to HHIMS user need more time to understand the possible questions asked by the user and problem with use of the MPI in hospitals. Private sector and preventive sector were not included and only the curative sector is used. In Future work Clinical repository or MCDS will be integrated to the PHN in the version 2 of the MPI. Retrieval of Past Medical History, Allergy History. Family History from multiple EMRs to the EMR at current care provider. Need to test in preventive and private sectorsand need longer period of observations for a profound understand of possible issues. Development of the citizens mobile application will help the patient s to track their clinical record online. This will be helpful in the future for continuation of care because of the tracking of the caregiver information and the practices will prevent malpractices by doctors.

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