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Study Site:	Anna Library at the University of King's
Course Number and Title	INF1341 System Analysis and Process Innovation
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Executive Summary

This paper provides an elementary investigation on systems and process of the study site – Anna Library at King's University (Anna Library hereon). The paper provides an overview of the loan service objectives, entities, and operations at Anna Library and employs Business Process Mapping Notation (BPMN) and Data Flow Diagram (DFD) to analyze the As-Is situation of the current workflow. Based on the result of BPMN and DFD analysis, the paper provides recommendations on potential automation and innovation ideas with the support of respective diagrams. Entity Relationship Diagram (ERD) is also provided in the DFD section as data model to illustrate the relationship between data and entity. In the process, the following potential changes including user-centric recommendations, digital material lending, drop-off bin with barcode scanner, RFID inventory management, direct access to ALMA platform, regression analysis on loan services, inter-library transfer system, and alternative material recommendations are highlighted. As part of a comprehensive evaluation, the paper provides comparison between the two modeling techniques BPMN and DFD to present the strength and shortcomings of respective methods on system and process analysis.

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1. Context for the Study

This paper provides an elementary investigation on systems and process of the study site – Anna Library at King's University (Anna Library hereon). The paper provides an overview of the loan service objectives, entities, and operations at Anna Library and employs Business Process Mapping Notation (BPMN) and Data Flow Diagram (DFD) to analyze the As-Is situation of the current workflow. Based on the result of BPMN and DFD analysis, the paper provides recommendations on potential automation and innovation ideas with the support of respective diagrams. Entity Relationship Diagram (ERD) is also provided in the DFD section as data model to illustrate the relationship between data and entity. In the process, the following potential changes including user-centric recommendations, digital material lending, drop-off bin with barcode scanner, RFID inventory management, direct access to ALMA platform, regression analysis on loan services, inter-library transfer system, and alternative material recommendations are highlighted. As part of a comprehensive evaluation, the paper provides comparison between the two modeling techniques BPMN and DFD to present the strength and shortcomings of respective methods on system and process analysis.

2. Analysis using BPMN

• Detailed Presentation of the As-Is situation

Overview of the entire process:
This paper provides an elementary investigation on systems and process of the study site – Anna Library at King's University (Anna Library hereon). The paper provides an overview of the loan service objectives, entities, and operations at Anna Library and employs Business Process Mapping Notation (BPMN) and Data Flow Diagram (DFD) to analyze the As-Is situation of the current workflow. Based on the result of BPMN and DFD analysis, the paper provides recommendations on potential automation and innovation ideas with the support of respective diagrams. Entity Relationship Diagram (ERD) is also provided in the DFD section as data model to illustrate the relationship between data and entity. In the process, the following potential changes including user-centric recommendations, digital material lending, drop-off bin with barcode scanner, RFID inventory management, direct access to ALMA platform, regression analysis on loan services, inter-library transfer system, and alternative material recommendations are highlighted. As part of a comprehensive evaluation, the paper provides comparison between the two modeling techniques BPMN and DFD to present the strength and shortcomings of respective methods on system and process analysis.

Areas of Special Interest
There are two areas of special interest reflected in this model. The first is in the usability of the online request system which is reflected by the process in the librarian's swim lane, and the second is in the accurate and reliable finding of the books in the library, which is reflected in the SLA's swim lane. As noted through the interview, the librarians often spend time searching for the availability of the requested materials or even outsourcing to other libraries. All this time can be used to maintain library operations and handle more loan requests. Additionally, the main interactions for Anna's library are done from patron to librarian, and then librarian to SLA's. As we can see in the model, both of the

interactions after checking the Loan status require the work from the librarian or the SLA in order to complete the business process. The librarian is tasked with finding, or outsourcing the book from a different library, and the SLA is tasked with going out and finding the book on the shelf. There are many steps in this process in which unnecessary time is spent trying to carry out communication between the different entities of people involved, and extra work is added on those who work in the library. The first area of interest aims to reduce this level of subcontracted work that is required, by reducing the work and process that librarians and SLA's need to do, and perhaps allow the patrons to take a hands on approach through a self-service portal. In the BPMN model, this could potentially reflect as moving some of the tasks from the SLA and Librarian swim lanes over to the patrons or a system that the patron would use. This would reflect that the process is being undertaken directly by the patron rather than being subcontracted to our other two entities. The second area of interest has to do with locating the books within the library. Updating loan information as missing or unavailable is a task that can become redundant and time consuming if the rate of which books are not found is high. It also creates inconvenience for the patron as now they are required to outsource the book from elsewhere. This area of interest focuses on the ability to find the books accurately within the building, and reducing the margin of error that comes with missing / misplaced books. These two areas of interests will be delved into further into the next section where we will discuss the different alternatives that we have considered to help tackle these issues.

As Is BPMN
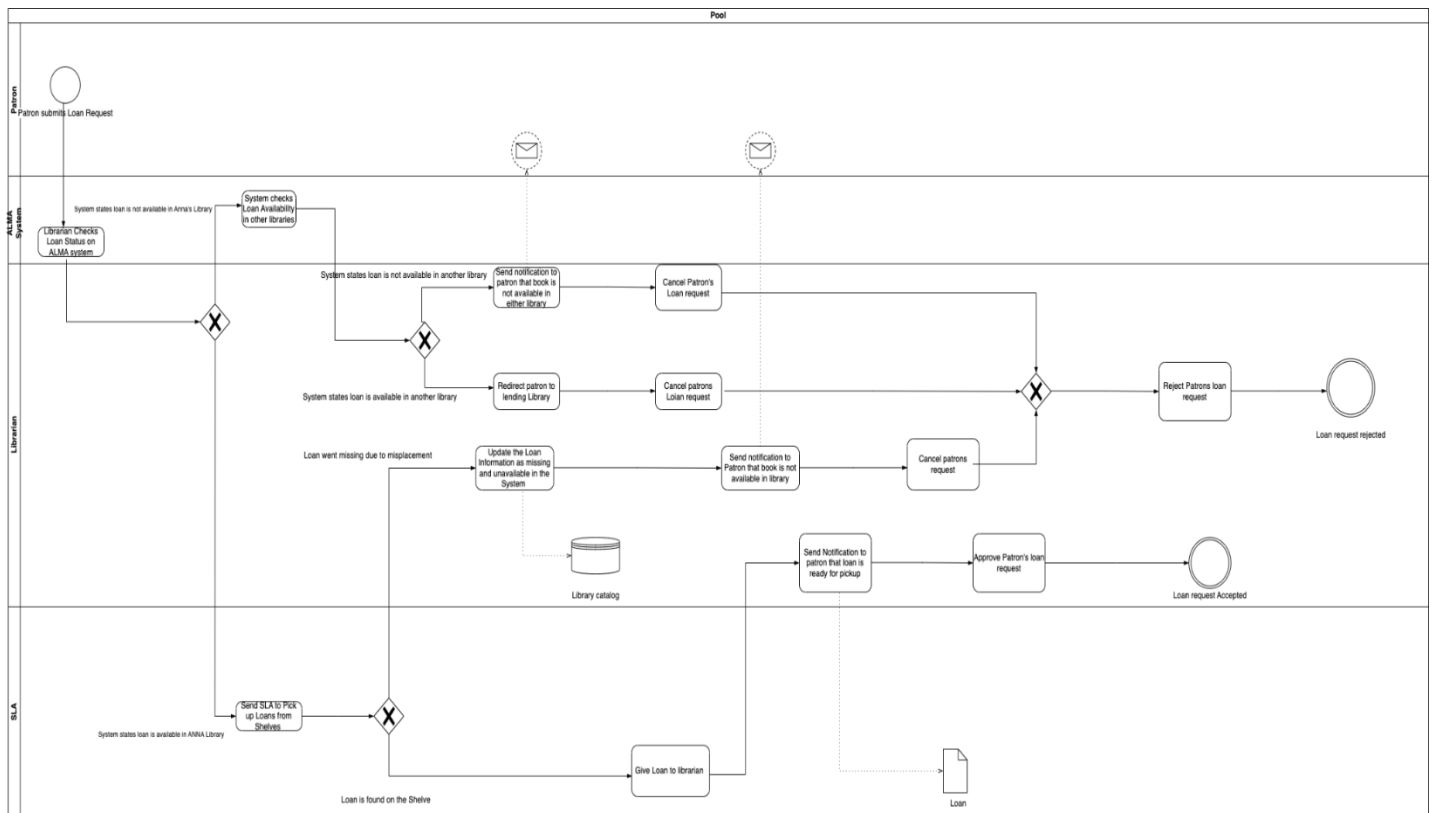
• A Summary of To-Be Alternatives Considered

Within the Anna Library's loan process, there is ample space for improvements. As with many libraries, the Anna library is continually navigating what it means to be an centralized location for knowledge in the digital age. The following proposed innovations and automations will address some of these digital gaps as well as focus on ways to save the time of the librarians and the student library assistants so that they can focus more on the operational needs of the Library. The following proposed improvements

Innovation	Description	Pros	Cons
User-Specific Recommendation System	Utilize machine learning techniques to provide personalized book recommendations based on patrons' preferences and history. Patrons can list the genres and material that they are interested in and the system will spit out recommendations. This can drive more engagement at libraries.	• Helps patrons discover new material. • Can lessen the time used for librarian consultation.	• Privacy concerns, this requires analyzing patron data and there could be concerns to the management of identifying data. • Availability of data
Digital Material Lending	Introduce a platform for borrowing ebooks and digital materials, catering to changing reading preferences.	• Expands the limits of the library- diminishes the physical limit as materials would be available online • 24/7 availability. Patrons would be able to access this platform whenever from wherever	• Licensing cost • Can be exclusionary to those who do not have access to electronic devices or internet connection
Inventory Management with RFID	Implement RFID technology for automated material tracking, check-in/out, and real-time location tracking. Reduces time in manual search for materials.	• Automates loan process • Faster service to the Patron	• RFID technology is very expensive in its upkeep and purchase • Requires further training of SLAs and other employees

Automation	Description	Pros	Cons
Book Drop-off bin with barcode scanner	Patrons can return books into drop-off bins and scan a barcode or an identifier on the book in order to show that book has been returned into the facility. This would help with keeping a record of books returned and inventory management.	● Cuts out the time and labor it takes for the librarian to collect returned books straight from the patron ● Books would automatically appear in the system	● Maintenance of technology
Self-Service Portal for Patrons through Library Mobile App	Patrons can check material availability at any time. This portal would provide real-time updates on requested material locations so that they could go find the material themselves, thus saving time. Can additionally incorporate augmented reality features to guide patrons to materials and enhance the self serve experience	• Reduce amount of time that Librarians spend manually helping patrons. • Patrons will not need to go to library to enquire about materials	• Need to develop troubleshoots if system ever goes down.
Predictive Maintenance for Library Equipment	Use IoT sensors and machine learning for predictive maintenance of library equipment, reducing downtime. For library kiosks, etc.	• Reduce cost of emergency repairs • Reduces downtime for faulty equipment	• IoT is quite expensive • Librarians will need further training on how to maintain this technology

• Detailed Presentation of Two To-Be Alternatives.

The two To Be alternatives that we will further explore will be implementing inventory management with RFID scanners (Innovation), and implementing a self-service portal for patrons (automation).

RFID

We believe implementing RFID scanner technology is an innovative way to address one of our main areas of interest which is missing or mishandled books. This technology would ensure that when books are either taken out or stocked back in, they are scanned at the specific location that they should be in. It would require each book to have their own unique barcode identifier, and the location to have a barcode identifier. With this approach, it would help keep track of the inventory by monitoring book

inflow and outflow and assist with accurate location finding. Below we have listed more ways in which this technology can lead to improvements as well as achieving organizational objectives.

To Be: RFID Chips
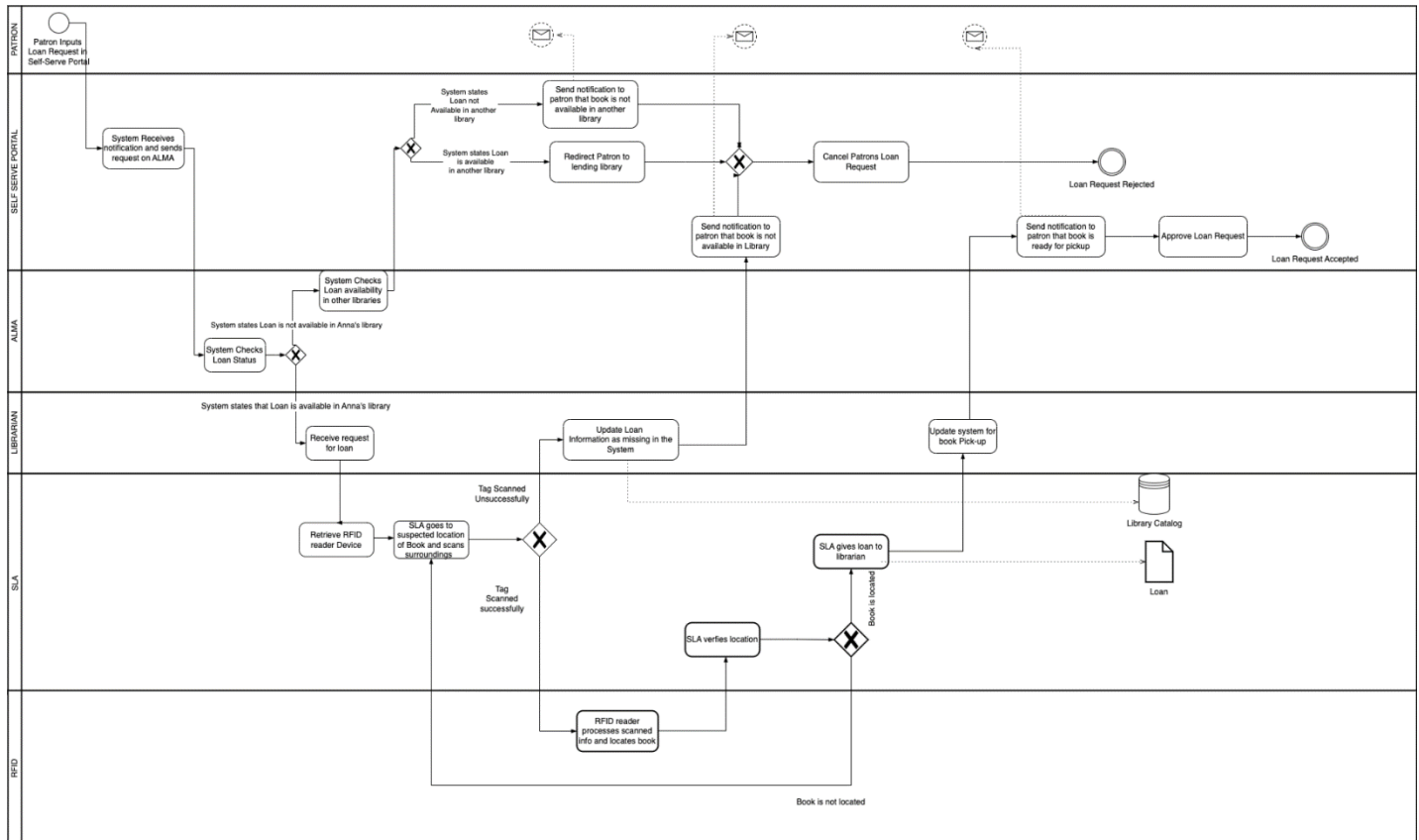
Efficiency / Time saving:
Being able to locate books accurately and automating the process of tracking the inflow and outflow of books can reduce the time that is spent by either Librarians or SLA's in searching for these books. This time can be used by the staff to run other library operations.

Accuracy / Reliability:
By being able to track where the books are, or when they've been taken out, it reduces the amount of error and increases reliability in the system. Librarians and SLA's can feel more confident that the book is available and don't have to turn away any patrons who may come into the library. It improves overall patron satisfaction and creates a more robust business process.

Data Analysis + Insight
RFID technology can also provide data on certain borrowing trends and timelines for borrowing, which can help inform the library staff on different ways to manage inventory / material management, and that can help with better decision-making down the line.

Self-Service Portal

The self-service portal is a way to automate the the recurring processes that a librarian or even an SLA may need to do. This approach is more user-centric rather than operational as it allows patrons to interact directly with the portal and be able to source books that they may need. Additionally, it can also save patrons time, if the book is not available at this library because they can make more use of their time by being redirected to a library that would have the book in stock and not make the trip to Anna's if they don't need to. This service would also drastically reduce the time spent by librarians and SLA's in sourcing for the book, finding other libraries, etc, because all of that is now done by the Patron. Below we have listed more ways as to how this technology can improve and achieve organizational objectives.

To Be: Self-Service portal
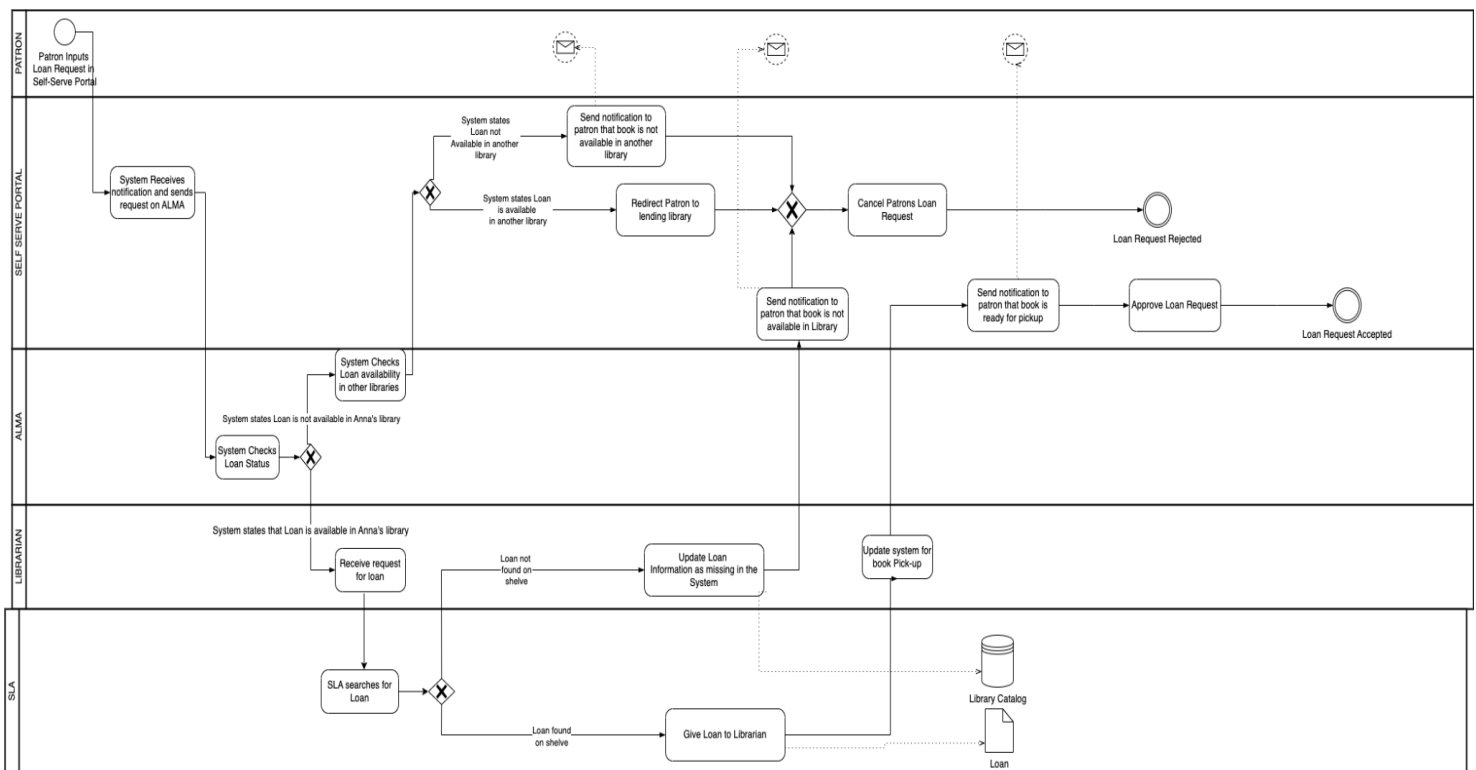
Efficiency and Time Savings:

Just as the RFID technology, allowing patrons to check for material stock, locate the location of the stock in the library, and even being given information of stock elsewhere are all tasks that can save the Patron. The patron does not need to go through the back-and-forth communication with the librarian as they will interact entirely with the system. On the other side, this also saves a lot of time for the librarian as they do not need to interact with patrons unless called upon, and can focus on operational tasks at the library. This ultimately helps Anna Library's bottom line as it streamlines processes for both patron and librarian.

User Experience:

This process enhances user experience for the client as now they can search for their books, be redirected to another library if needed, and be assisted in finding the book at Anna's library, reducing the overall interactions required. An feature that is key would be some kind of augmented reality feature where the Patron is directed through bookshelves and the building itself in order to find the exact location of where the book may be. This helps with accessibility, as well as creates for an efficient process as one does not need to spend time sourcing for where certain locations in the library are.

Potential Drawbacks / Tradeoffs

As promising as all of these sound there are definitely some potential drawbacks and trade-offs that we have understood from this process.

Initial costs / Re-occurring costs:

The costs for implementing both RFID technology and a self-service portal with an augmented reality feature could be substantial. Different analyses of ROI, patron traffic and demand, or frequency of errors would need to be conducted to truly assess the demand for said technology implementations, which may not yield potential returns until much later. Maintenance of said systems could also prove to be costly as updates, bug fixes, or updating physical equipment could also come into play.

Technology Adoption

Adopting this new technology could also take a bit of a learning curve for both Patrons and staff. This learning curve may deter some patrons from wanting to interact and could potentially also slow down the overall loan process.

Privacy Concern:

Implementing Augmented Reality features could be a cause for privacy concerns as they would need access to real time location and camera access, which may feel invasive to some.

Ultimately, the trade-offs considered are primarily between cost / implementation and efficiently and timesaving. An in-depth cost analysis could help understand whether or not the system is beneficial to be implemented in the long term, but that all depends on Anna library's ultimate long-term goals.

Data Modeling Explanation:

The data modeling helped by providing a visual summary of the overall process. Being able to visualize how the process flows from the beginning to the end helps us determine where certain areas of interest may be, or where certain redundancies may come up. In the context of our model, we saw our main areas of interest at the points of our XOR gates and the overall activities in the respective swimlanes. The gates showed us the differing tasks that the SLA's and Librarians had to undertake in order to determine the availability of the books in the system, and the subsequent tasks that followed to further complete the process. These subsequent tasks are what helped us come up with the idea of the self-service portal, and move the tasks to a system that the patron can interact with, rather than the librarian doing everything. This not only frees up the swim lanes for both SLA's and Librarians but also reduces the amount of work librarians and SLAs need to do, which allows them to focus more on library operations.

Data modeling also helped us "simulate" how the new process would look like if we implement the new technologies under study. We are able to visualize the work being delegated to the patrons and show how these technologies free up tasks for the Librarians and SLAs.

Ultimately, Data modeling helps us break down the different processes that occur at the library, into workable parts. We begin to understand the relationship between different entities such as the patron, librarian, SLA, and the different systems utilized. Our approach was to try and reduce the amount of communication and relationship required so that it creates for a more streamlined process for the patron. This does not mean that patrons are not allowed to interact or communicate with a librarian, it simply means that they are better equipped to do so when needing solutions.
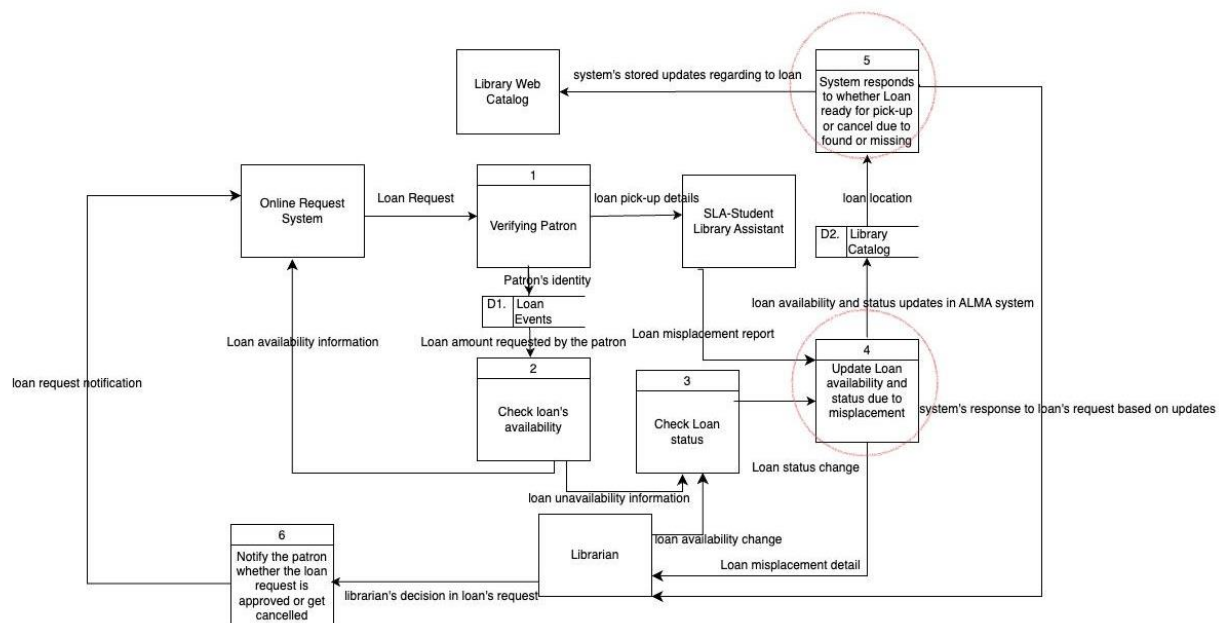
3. Analysis using DFDs

• Detailed Presentation of the As-Is situation

DFD As-is Context Diagram
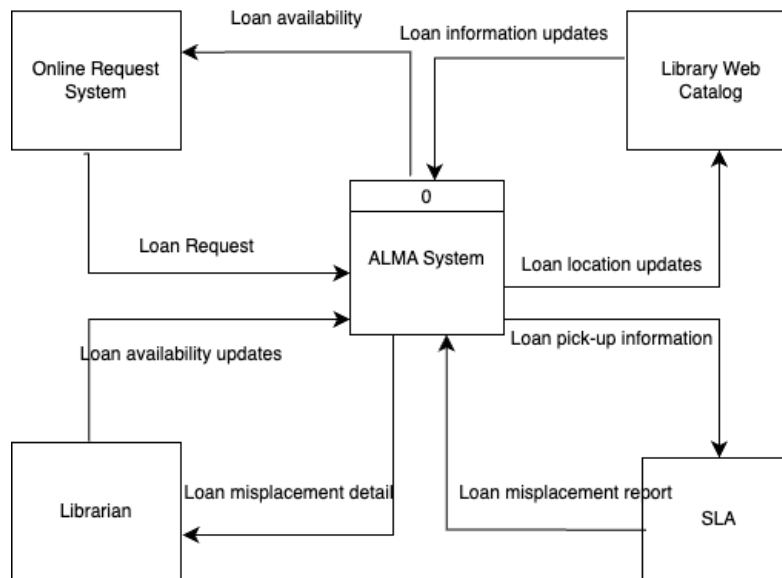
DFD As-is Level-0 Diagram

Overview of the entire process:

Based on the context diagram, the loan processing process begins when the ALMA System receives the data input of the loan request from the Online Request System. The librarian then uses the information stored in ALMA to check whether the requested loan is stated available in the system. During this stage, if the ALMA system indicates the availability of the requested material, the librarian will send SLA-Student Library Assistant-to pick up the material. The party can access the pick-up details, including locations through ALMA. If the loan is found on the specific shelf as the system prescribed, the SLA will bring the book and make it ready for patrons to pick-up.

Nevertheless, as shown in the diagram, exceptions do occur. The requested books which are stated as available might not be found due to misplacement. In such cases, the SLA will report the loan misplacement back to the ALMA system. The librarian will then receive the loan misplacement detail from the system and proceed to cancel the loan request, updating the requested loan status into unavailable. All these updates will be recorded in the Library Web Catalog in real time for future reference, which the ALMA system will also correspondingly update its recorded loan information with the updates from the catalog. From the diagram, it's evident that ALMA is the core system upon which the loan request processing depends. All data inputs pass through it, and the rest entities interact with it during the loan processing.

To gain a more detailed understanding of how the system plays a crucial role in fulfilling loan servicing, let's examine the Level-0 Diagram. The mechanism of the ALMA system is broken down into several detailed processes. The system checks loan availability and status upon receiving the borrowing request. If the loan is unavailable, the system proceeds to check whether it is missing due to misplacement. The librarian collaborates with the SLA, which if the latter discovers that the loan is currently missing due to misplacement and couldn't complete the pick-up, the librarian will receive this misplacement details from the SLA through the system and then update the loan availability in the system. Meanwhile, the library catalog database will correspond and update its data with any changes in the ALMA system. If there has been a loan update regarding its availability and status stored in the library catalog, the catalog will then send the updated loan locations–whether it has been found or went completely missing–to the ALMA system, which the system will generate response to whether the patron's request should be canceled or approved based on the condition. Before the response gets directly sent to Librarians and waiting for her final decision on whether to approve or cancel the request, all the updates regarding the loans will be sent to the library web catalog to make sure the loan information is well-updated in the Library web catalog for future reference. After the librarian made the final decision in the patron's request, the notification will be sent to the online request system as to whether the request got finally approved or canceled, which the patron can access to the online request system by themselves and check it.
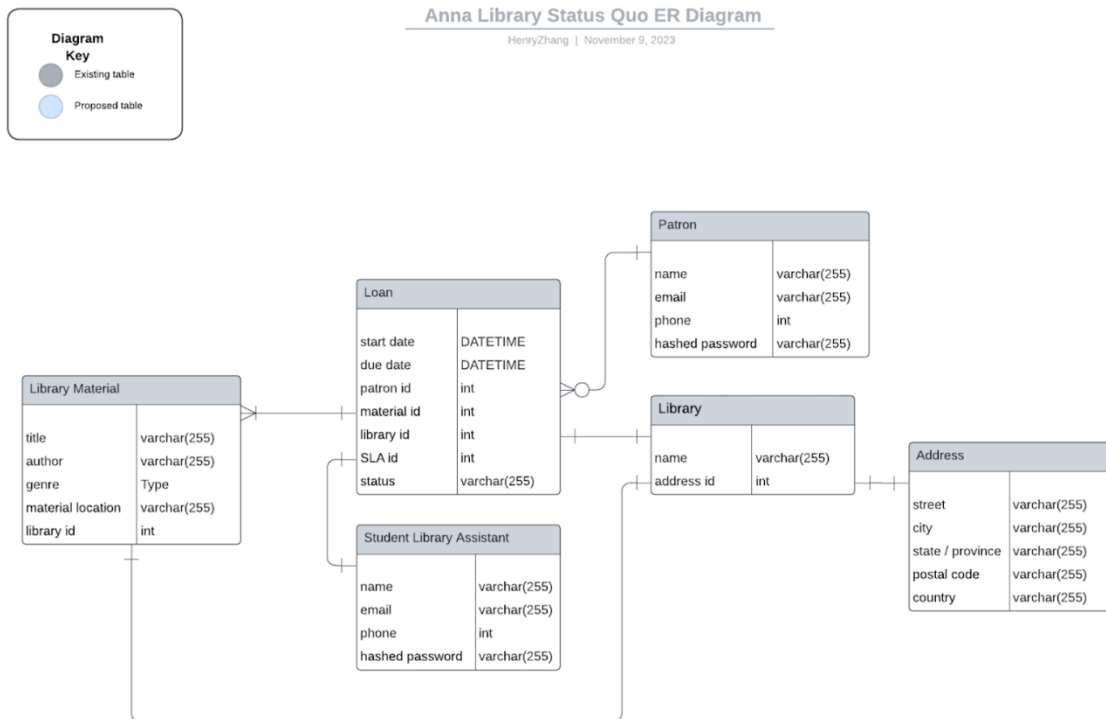
Areas of Special Interest:

Based on the described process mechanics, several issues can be identified. First, since there are no other libraries involved in the loan service process, there are no alternative loan resources available. This means that a missing loan due to misplacement directly results in the cancellation of the material request. If an internal transfer service were available between the Anna library and other libraries, wherein the requested material missing at Anna library is available at another library, the librarian could assist the patron in fulfilling the request by arranging an internal transfer of the material from the other

location. This process would save patrons a significant amount of time that they would otherwise spend visiting other locations in person to locate alternative copies of the materials they want.

Secondly, patrons, who are essential participants in this process, are currently not included in the system. They can only access the online request system, while the ALMA system, which handles the majority of the loan service process, remains exclusively for use by library staff. This restriction may be understandable due to data security concerns, it overlooks the fact that the processing procedures within the ALMA system assigned to the librarian and SLA are tedious and time-consuming. This setup restricts patrons from accessing requested materials or conducting self-searches for material availability. To enhance the efficiency of the loan service, granting patrons the right to use the ALMA system to check material availability and status could be beneficial. Librarians should only intervene if the materials indicated as available cannot be found by the SLA. In such cases, the loan data should be adjusted based on this exceptional condition, allowing the patron to either cancel the request if the material cannot be found, or wait for an alternative material to be ordered and transferred from another library.

Thirdly, frequent occurrences of misplacement significantly slow down the entire process, requiring numerous changes and updates to proceed to the next stage. As misplacement is a human error, its frequent occurrence increases the uncertainty of the loan process. It functions like a bug that disrupts the smooth operation of the process, resulting in the cancellation of requests. A solution should be devised to prevent this human-generated mistake from occurring frequently. Additionally, a better method for handling such issues without compromising the efficiency of the overall process should be implemented.

Data model for As-Is Situation

• A Summary of To-Be Alternatives Considered

Automation	Description	Pros	Cons
Enable Patron's access and user-interface to ALMA platform	Currently only librarians are allowed access to ALMA platform. Patrons could not check material availability and would have to submit an availability enquiry to the librarian. This automation grants access to part of ALMA system by sharing part of the ALMA user interface with patrons.	• Ensure seamless access to availability of materials that is not prone to human errors. • Reduce time cost for librarians to handle availability enquires.	• Cost to amend the user interface and share partial functions of the ALMA system
Convert popular materials into soft copy	Based on current statistics and with respect to copy right, convert popular materials into softcopy that is accessible to patrons on-site at Anna Library.	• Ensure patron's access to popular materials in the event of misplacement. • Cost to convert popular materials is relatively small (Only scanning is needed).	• The process might be time consuming if there are many popular items in Anna Library • There may be obstacles in obtaining copy right from the author to convert materials into softcopy.

Regression analysis on seasonal loan spike and factors of misplacement.	Based on current statistics on loan services, conduct regression analysis on seasonal spike. Considering the nature of academic library, students and researcher have seasons and there may be discernible trends between their loaning schedules and misplacement. The insights into data would help prepare the library in provision of its loaning services especially in predicting factors that causes misplacement.	• It would provide a better picture on the root cause that causes misplacement. • The insight generated may offer potential solution that reduces misplacement rates in Anna Library • Pending on granularity of data, this could in the long run support Anna Library in diagnosing the reason to material misplacement.	• Requires librarians to equip themselves with knowledge and software of regression. R studio should be sufficient and could be downloaded for free considering the limited amount of data needed to be analyzed within an academic library.

Brown, Chan, Li, Singh, Zhang   **13th November 2023**

| Innovation	Description	Pros	Cons
Inter-Library Internal Transfer System	Utilizes internet to connect databases of libraries with Anna Library. This innovation enables librarians to lookup availability of requested materials in other libraries and submit internal transfer request for the material to be shipped to Anna Library on behalf of patrons.	• Enable patrons to access a wider base of materials across libraries network. • Improves transparency of materials between libraries.	• Costly to maintain an intern-library internal transfer system considering the scale of such project. • Investigation effort would be increased in case of misplacement event.

| Regular RFID inventory checking robots (Regular sanity check on material availability)	Originated from Amazon warehouse inventory management robots, a weekly/monthly inventory checking can be performed at a smaller scale on materials inside the library. This sanity check aims to prevent the occurrence of misplacement as any misplacement could seriously hinder the loaning process and requires manual fixes which may eventually result in more human errors. To minimize human-error, RFID robots with sanity check could minimize human investigation effort in case of misplacement occurrence and narrow down the event timeline for further investigation.	• Ensure up-to-date records are maintained at the library and greatly reduces the risk of misplacement. RFID is a mature technology with accurate inventory tracing record. Large corporations including UNIQLO tracks apparel inventory with the same technology and would not be a problem to implement in the scale of an academic library. • The reduction in human effort implies not only less error but also more labour hour for other activities such as events for kids.	• Requires specialist in RFID to include the RFID technology in an academic library. • This would be a relatively large and costly project considering the number of books it required for RFID to be added.

| Alternative recommendation in case of unavailable material | Leverage machine learning and AI, alternative material with similar content can be recommended to patrons in the case where library network does not possess the material.

Recommendations could also be made to point the way for patrons to access the material through channels such as Indigo or Amazon. | • Allow patrons to further explore alternative in case of difficult situation such as textbook borrowing (There might be older edition or similar textbooks written by the same author.)
• Allow patrons to explore a wide array of different options of materials. The provision of more options would hopefully lead to a more tailored and fruitful readership experience. | • It would be costly to implement machine learning and AI given the level of computing power it requires. |

• Detailed Presentation of Two To-Be Alternatives.

DFD To-be Context Diagram - Automation: Enable Patron's access and user-interface to ALMA platform. Rename automated system as Library Management System
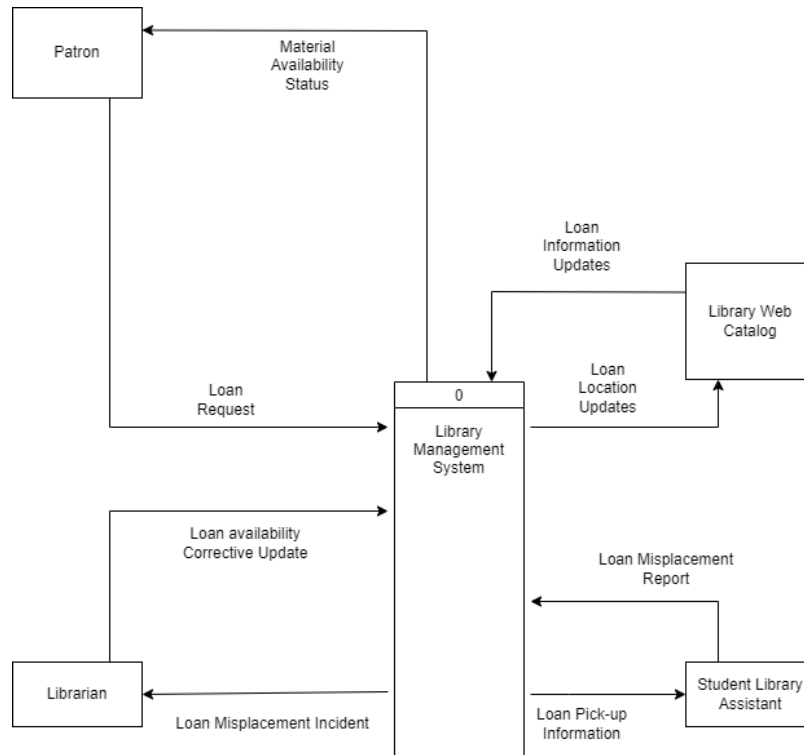
DFD To-be Level 0 Diagram - Automation: Enable Patron's access and user-interface to ALMA platform. Rename Automated system as Library Management System
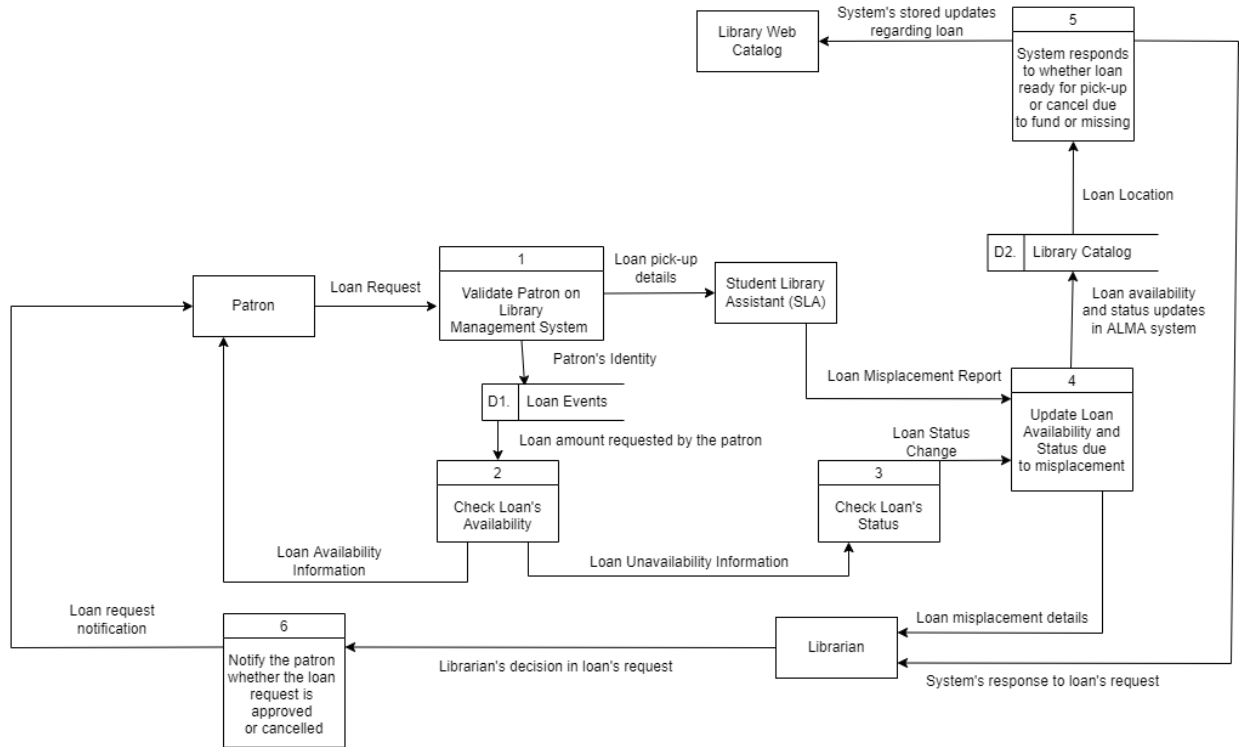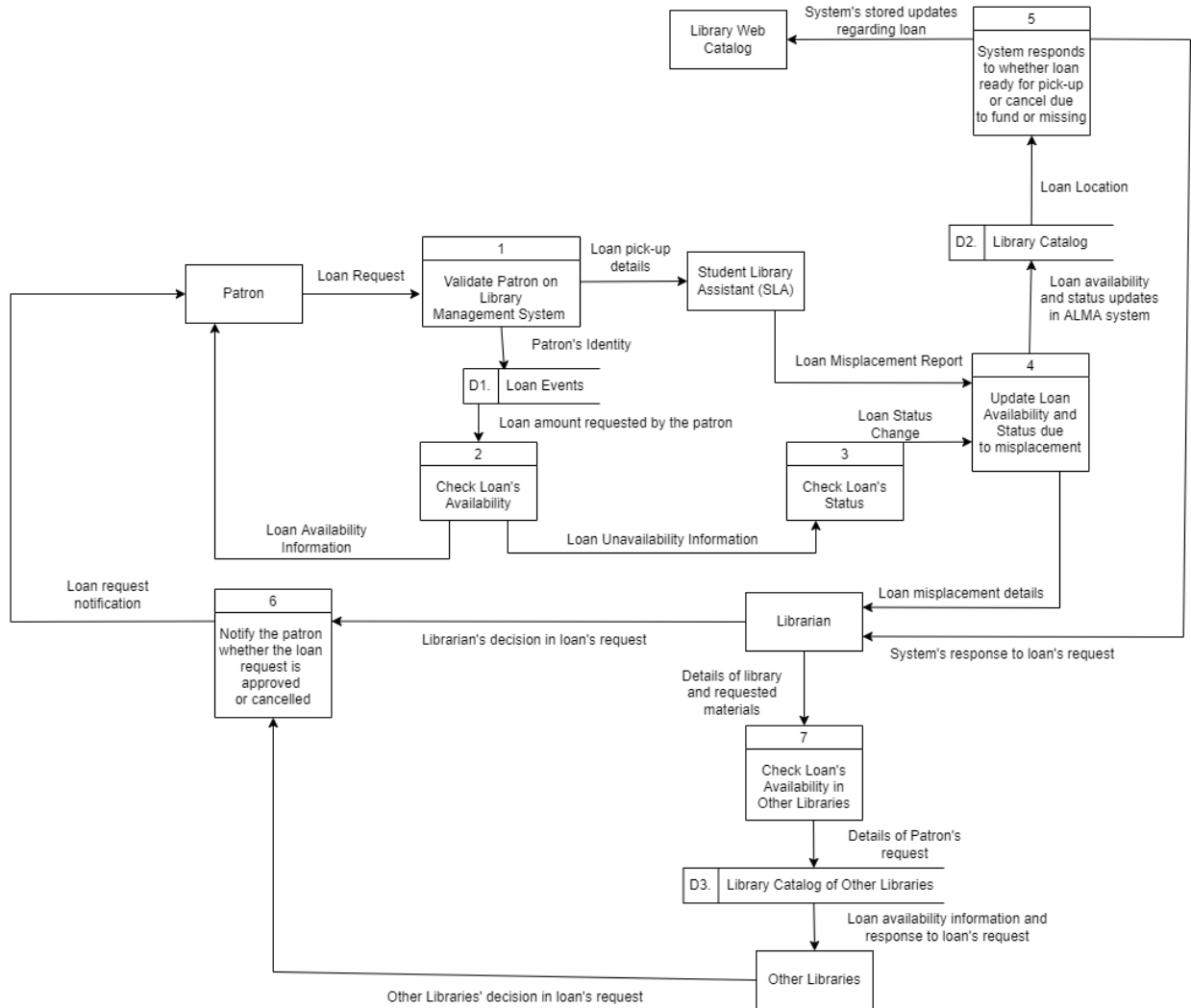

DFD To-be Automation Overview:

The automation chosen is the enablement of patrons to access the user-interface of ALMA platform which would be subsequently renamed as library management system, a system that allows patrons to submit book requests and check availability through self-service. The DFD diagram replaces the Online Request System with the patron. This automation reduces the need to have a librarian's assistance in accessing the Online Request System. Prior to this automation, the process flow requires the Patron to speak with anyone in the library who has the right to access the Online Request System for the patron. With this automation, patrons could self-service at a system interface that is part of a system named library management systems which replaces the original ALMA system. The new system enables patrons to self-service book request and availability query, fundamentally reducing the workload of staff in the library through a simple automation in online request system.

DFD To-be Context Diagram - Innovation: Inter-Library Internal Transfer System
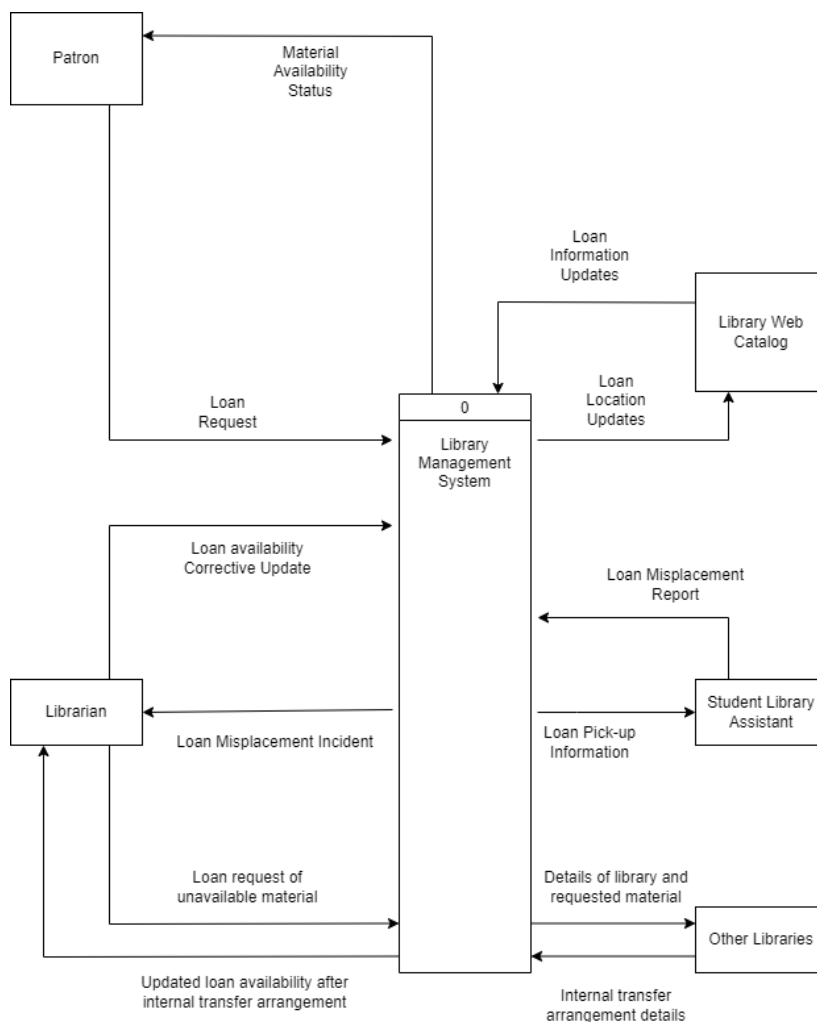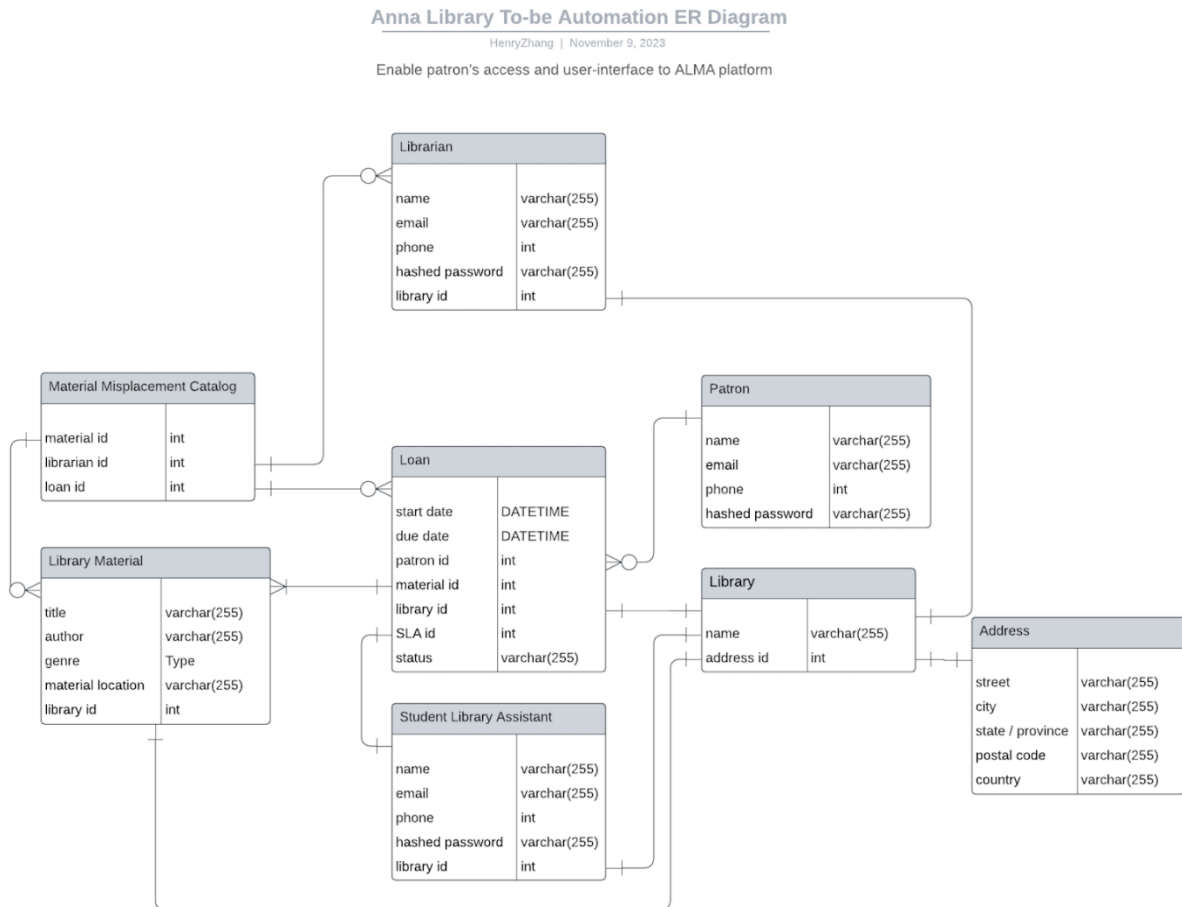
DFD To-be Level 0 Diagram - Innovation: Inter-Library Internal Transfer System

DFD To-be innovation Overview:

The innovation chosen is the Inter-Library Internal Transfer System which allows librarian to submit availability query and book requests to other libraries in the case where the patrons' request could not be met by Anna Library. The DFD context diagram connects the extra entity "Other Libraries" with the library management system which would send details of library and requested material of the patron to other libraries and in return receive internal transfer arrangement details should the requested material is available and loanable per consent of librarians in other libraries. The DFD Level-0 Diagram further indicates the access to datastore of library catalog of other libraries to enable loan availability checking in other libraries.

Data model for To-be Situation

Anna Library To-be Automation ER Diagram
HenryZhang | November 9, 2023
Enable patron's access and user-interface to ALMA platform

4. Comparison of the Two Modeling Techniques

Utilizing both BPMN and DFD modeling for conceptualizing the ANNA library loan process has been rewarding. Each technique has its weaknesses and strengths and to truly get a full picture of the process you need to be adept in doing both. Generally, BPMN is very effective at modeling the whole business process from end to end in a holistic manner. DFD is a bit more granular and examines the way data is moved and manipulated throughout the business process. Additionally, BPMN is typically chronological and has some semblance of temporal limits whereas DFDs do not account for time. Both techniques are great, however, they each have their strengths and weaknesses. DFD seems to fall short when a stakeholder is in need of a comprehensive view of the business process. There is typically very limited process detail in DFDs since they primarily focus on data flows. On the contrary, the simple presentation of DFDs is perhaps its greatest asset. They are typically quite easy to understand and interpret because they isolate the data flows without going into the knitty gritty of the process. When presenting these models to stakeholders, it is imperative that what you show them is comprehensible, and DFDs seem to do a great job at keeping it simple. BPMN's strength lies in its ability to display the whole business process on a high level. There is a very diverse set of symbols and notation that make it so that is is feasible to model any type of business process. The weakness of BPMNs is that they do not really go into the processes at a very granular level and often times they can get pretty complex depending on the business process. Even simple tasks at times can require a lot of notation which could take a lot of effort for a stakeholder to comprehend. It especially falls short when the business process in question is more data-intensive than activity.

The process of modeling BPMN and DFD inherently helps find any holes there are in the business process or the way data is flowing. For example, when we were modeling the as-is BPMN, we ran into difficulty discerning the specific task that the Librarians and the SLAs carry out. After recognizing this confusion, we were able clarify with the member of the group who has best knowledge of the business process. This speaks to the BPMN's strength in displaying activity steps and noting who does what. When it comes to improvements, the as-is BPMN model also allowed us to see specifically what parts of the process were time-consuming and manual when they did not have to be. For example, our innovation which was the self-service portal was developed when we saw the amount of manual searching the librarian and the SLA had to do in the diagram. As for DFD, it greatly assists in clarifying the types of data being transported between different business activities and entities in a broader, more comprehensive review of the business process. The context diagram for the as-is situation elucidates the core structure of how the loan process was carried out, simplifying complex business processes into a diagram that provides a clearer overview of the system and its interactions. It helps stakeholders, including non-technical ones, in understanding the system at a high level without driving into details. In comparison to BPMN, which focuses on the actions taken by different parties in the process, the use of data stores and widespread indications of data flows throughout the DFD drawing provide a clearer and more comprehensive understanding of how efficiently the process mechanizes in response to different data inputs and outputs generated within its inner workings. For example, in the diagram, the representation of how the loan request serves as a data input into the loan process and transforms into a different data output after undergoing business activities is useful in understanding how information is exchanged and processed within the system.

5. Methods, Activities, and Tools Used

The interviews with the library staff at Anna Library have been extremely helpful in gathering sufficient information regarding the detailed business activities involved in the loan process. There were instances when we needed to refer to the specific processes that each staff member is involved in to accurately model the process. Asking a multitude of questions allowed us to collect various answers, aiding in addressing any uncertainties regarding the loan process during the modeling phase. Through this process, we recognized the importance of obtaining firsthand information from individuals directly engaged in the business process during investigation. Their experiences guided us in determining the direction for modeling the business process, thereby enhancing efficiency in identifying existing problems and clarifying any confusions raised during our investigation. For instance, the idea of implementing an interlibrary change was contributed by one of the interviewees. Also, through her numerous experiences dealing with book misplacements, we identified the issue of loan misplacement as a top priority to be addressed. This insight influenced the development of our to-be models, focusing on ways to prevent such occurrences from happening too frequently.

For Data Flow Diagram and BPMN diagram To-be analysis, draw.io is used. The To-be analysis is based on interview results with a librarian at Anna Library conducted by Eden, one of our team members, and case study of business of similar nature (Library management & warehouse management). The limitation of the current analysis in Data-Flow-Diagram is that it only shows the flow of data which unlike BPMN fails to show the flow of control. The timing of flow of data is not indicated (Weekly, daily, or on demand). The diagram is constructed on multiple assumptions of scenarios such as misplacement and unavailability in Anna Library, which may be difficult to comprehend solely from the flow of data.

6. References

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7. Statement of Individual Contributions

Jaydon:

- Created BPMN models for as is and one of the alternative "to be" (RFID)
- Created tabular presentation of the pros and cons and description of the three automation and three innovation for BPMN section
- Wrote portion of activity 4 section
- Overall comprehensive check of BPMN section
- Completed comparisons of DFD and BPMN model

Chan Marco Kai King:
- Completed formatting as per marking scheme
- Wrote the Executive Summary
- Constructed DFD context and level-0 diagram for To-be Automation (Patron ALMA system access enablement) and written its overview
- Constructed DFD context and level-0 diagram for To-be Innovation (Inter-Library Internal Transfer System) and written its overview
- Completed the summary for 6 to-be alternatives (Three automation and three innovation) considered for DFD
- Completed Methods, activities, and tools used for DFD To-be analysis
- Overall comprehensive check of DFD section (Except for ERD)
- Compiled references and consolidated the whole report.

Eden-Hongting Li
- Created DFD context and level-0 diagram for As-is situation and written its overview
- Identify the current existing problems for the as-is process model based on the analysis
- Create the business logo for the process
- Conduct the interviews with the library staff to get detailed information for the model building.
- Comparison between BPMN and DFD modeling techniques in bringing out the process performance.
- Methods, activities, and tools for interviews.

Rajveer-Singh:
- Created BPMN models for one of the "To be" alternatives (Self service portal)
- Completed "Overview of the entire process" section for BPMN
- Completed Areas of Interest section for BPMN
- Completed explanations of RFID + Self Service Portals in context of BPMN
- Completed data modelling section for BPMN
- Updated methods section to reflect BPMN

Zhang Cao:
- Created ERD diagram for both as-is and to-be situation in DFD
- Wrote the context of study