IMPROVING ORDERING AND ACQUISITION OF LEARNING RESOURCES

BSc Thesis Industrial Engineering and Management

By

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UNIVERSITY OF TWENTE.

AUGUST 30, 2021

Bonhoeffer College
VERRIJKT JE TOEKOMST.

This report is intended for Bonhoeffer College and the examiners of the University of Twente in the context of a bachelor thesis for the bachelor study Industrial Engineering and Management.

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Title	Improving ordering and acquisition of learning resources
Subtitle	BSc Thesis Industrial Engineering and Management

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Date of publication 30 August 2021

Number of pages 39

Number of appendices 1

Preface

This bachelor thesis is the result of my bachelor graduation assignment at Bonhoeffer College. The thesis is written as part of the bachelor study Industrial Engineering and Management at the University of Twente.

In this report, I will provide a solution that is an improvement to the process of ordering and acquiring the learning resources at Bonhoeffer College. Since I was familiar with the company I really looked forward to diving into one of their processes to improve it. I would like to thank Bonhoeffer College for facilitating this bachelor thesis.

In particular, I would like to thank my supervisor from Bonhoeffer College, René van Arnhem. He gave me the opportunity to work on this problem and he gave me the freedom to design my research as I liked. He was always ready to help and answer my questions. My thanks also go out to the employees of Bonhoeffer College and Iddink for their input during the interviews.

Lastly, I would like to thank Mike Monson, my supervisor from the University of Twente, for all his help and patience with me. He provided me a lot of feedback and always had time to chat about my questions. I have learned a lot from our meetings and all the feedback I have received.

I hope you enjoy reading this thesis!

Esmée Smellink,

Oldenzaal, July 2021

Management summary

Problem context

Bonhoeffer College is a collection of six high schools located in Enschede. At these high schools, the students use both physical and digital learning resources to support their learning. The digital learning resources are not always available to the students at the start of the year, which they should be. This has multiple causes, for example, parents do not order the learning resources on time, links are not coupled in Somtoday, or the digital learning resources are not linked to the study. The main cause of all these problems is bad communication of information and this can be improved by the implementation of an information system in the process of the ordering and acquisition of the learning resources. Therefore, the research question is:

What are the processes to be performed by an information system in order to ensure that the ordering and acquisition of learning resources at Bonhoeffer College are done efficiently?

Problem-solving approach

An information system is a work system that provides and maintains an integrated information flow throughout an organization. It contains software, hardware, data and users. For this research, the Design Science Research Methodology is used in order to not only design the artifact, but also gain "knowledge and understanding" (Hevner & Chatterjee, 2010) about the problem and its solution. The design of the information system is done according to the Software Development Lifecycle (SDLC). In this research, the first three steps of this cycle are performed: preliminary investigation, system analysis and system design. In the first step, the current process is analysed and improvement points are composed. For the system analysis, the requirements for the new information system are determined and for the third step, a model is made that shows the processes of the designed information system.

Current situation

The current process of making the digital learning resources available to the students consists of three subprocesses: the ordering and acquisition of the learning resources, accessing the digital learning resources and solving problems. At the start of the process, the lists with learning resources for next year are made by the course section leaders (CSLs), checked by the learning resources coordinators (LRCs), and then send to Iddink (supplier of the learning resources). Iddink then mails the students that they will have to order their learning resources for next year. The orders that Iddink gets for the digital learning resources are sent to Edu-iX, a content-hub, who then sends the right order data to the right publishers. The links to the digital learning resources are coupled in Somtoday (student administration system) to a year and study, and the digital learning resources are now available to the students. To access the digital learning resources the students have to open Somtoday, then go to 'learning resources', click on the name of the course and then on the link that is shown.

If students cannot reach their learning resources they contact the LRC of their location. LRC checks if the student tries to open the digital learning resources the right way, if all their learning resources are delivered and if their accounts of Iddink and Somtoday are coupled. If the problem is still not found, the LRC contacts Iddink or one of the publishers.

Conceptual design

Flowcharts with explanations were made of the processes for the information system. The conceptual solution describes the following processes:

- The user enters their credentials, these are validated against the User Authentication Data (User Data), and subsequently, the user has entered the system. On the dashboard, the system shows the user the information they are allowed to see and the processes they are allowed to access according to the User Data.
- System Administration creates the New LR and New Allocation Data from the Current LR. The data entities are edited by the CSLs and then checked by the LRCs. Once the list is correct, the LRCs create the Current LR for next schoolyear from that list. They also create the Current Allocation Data, which contains a record for each combination of learning resources, location and course.
- The Current LR and Current Allocation Data are exported to Somtoday and both data entities are sent to Iddink.
- Parents login at the website of Iddink with the student's name and number. The orders that Parents place at the website of Iddink are sent to the system. The LRCs use this data to create an order for the suppliers.

Conclusion

The aim of this research was to design an information system with efficient processes to improve the communication of information within the process of ordering and acquisition of the learning resources at Bonhoeffer College. The new information system provides a solution to the bad communication of information by facilitating processes that are more efficient, e.g. having only one version of each data entity with the information system as the only source of information.

Recommendations

- To improve the communication of information within the process of ordering and acquiring the learning resources, the information system will have to be further designed, developed and implemented.
- The information system can be expanded by giving it control over the communication of information for more processes within Bonhoeffer College. It could also be used in other high schools.

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Abbreviations

LRC:	Learning Resources Coordinator
CSL:	Course Section Leader
DSRM:	Design Science Research Methodology
SDLC:	Software Development Lifecycle

1. Introduction

This thesis will present a solution in the form of flowcharts with accompanying explanations for a new information system, to solve the problem of bad communication of information for Bonhoeffer College. In this thesis the problem is identified, the approach to solve the problem is given, the current situation is described, and a solution is designed.

1.2 Introduction of the organisation

Bonhoeffer College is a collection of six high schools located in Enschede. The six locations are: Bruggertstraat, Geessinkweg, Van der Waalslaan, Wethouder Beversstraat, Vlierstraat PrO and Vlierstraat Expertisecentrum. At these schools, education is given at different levels, from practical education to gymnasium. There is also a centre of expertise for students that need extra support in their education.

The students of Bonhoeffer College are using both physical and digital learning resources to support their education. Both require a process to make them available to the students at the start of the schoolyear. Digital learning resources have not been used for very long and it is too often the case that a student cannot access all of their required digital learning resources.

Bonhoeffer College needs improvement in the process of ordering and acquiring the digital learning resources. The students should be able to access all their required digital learning resources on time. To achieve this, fewer problems have to occur at the start of the schoolyear and problems that do occur have to be solved efficiently. They need a solution that will make the process more efficient by facilitating and regulating the ordering and acquisition of learning materials.

1.3 Parties involved

There are a number of parties involved in the process around digital learning resources and therefore involved in the research. The parties have different roles in the process and experience different kinds of problems.

- *Head of operations*
  The head of operations of Bonhoeffer College is the main problem owner. He is responsible for making sure the process around the (digital) learning resources goes well.
- *Learning resources coordinators: LRCs*
  Every location has its own LRC. The LRC is responsible for all the learning resources. Most problems that students and teachers experience with the digital learning resources pass them first.
- *Application management*
  Application management is responsible for the Somtoday application. If students cannot log in to this student administration system, they will not be able to access their digital learning resources.
- *Course Section Leaders: CSLs*
  Each location and course has a course section with a CSL. The CSLs decide on the (digital) learning resources to be used for their course and location.
- *Parents*
  Most of the time the parents of students order the learning resources and ask questions when problems occur. Therefore the parents are part of the process.
- *Students*
  Students have to use the digital learning resources. If they are not able to access them, they are not able to learn from them.

- *Teachers*
  The teachers also use the digital learning resources. They can use them in their classes by showing them on the digital board, to find extra learning material for students to use or to let students do the homework online. The latter is however only possible if students can access the digital learning resources. Teachers have to deal with students that cannot access their resources during their classes, and this may cost valuable time.
- *Iddink*
  Iddink is an organization that provides the physical and digital learning resources for Bonhoeffer College. For the digital learning resources, they are a mediator between Edu-iX and the publishers. Some of the problems that prevent students to access their learning resources can be solved by them.
- *Publishers*
  The publishers of the learning resources are also responsible for some of the problems that are experienced, by, for example, making the digital learning resources available too late.

1.4 Identification of the problem

At the start of the schoolyear, all students should be able to have all their digital learning resources available. However, this is not always the case. There are quite a few problems that stand in the way of this happening. These problems occur in the process of ordering and acquiring the learning resources, in which different parties and systems are involved.

One party in the process is the parents of the students. At the start of the schoolyear, or when a student changes classes in the middle of the year, the parents or students themselves have to order the learning resources via the organization Iddink. This organization is the supplier of learning resources for Bonhoeffer College. When the learning resources have been ordered, the publishers of these learning resources and the organization Iddink have to make them available and provide the licenses that are needed by students to access the digital learning resources. After this, the digital learning resources will be accessible to the students at Somtoday, which is the student administration system used by the students. At each location of Bonhoeffer College, the LRC is responsible for solving problems that occur in the process and making sure each student can access their digital learning resources.

The parties involved in the ordering and acquisition of the learning resources do not get the information to take the right actions. It is not well communicated what each party is supposed to do within this process and what has already been done by others. Furthermore, they are not being informed about where in the process they are. This means that the communication of information within the process is not going well and this flow of information should be improved. There should be a system that facilitates and regulates the communication of information and the activities from the process. This information system should inform all parties about what to do and provide information about what is going on in the process or where in the process they are.

1.5 Problem cluster

From interviews with the LRCs, the head of operations, Iddink and application management, problems occurring in the process were identified. A lot of different problem scenarios indicate the causes of digital learning resources not being available to students on time. At each party in the process, problems are occurring either with ordering or with the acquisition of the learning resources. The cause of the problems is not with one of the parties in the process, but with a poor flow of information throughout the process. All problems that are occurring, described in the problem cluster in Figure 1.1, have a main cause, namely bad communication of information

between parties in the process. If information is well communicated to all parties in the process, the problems should not occur and the process will be more efficient.

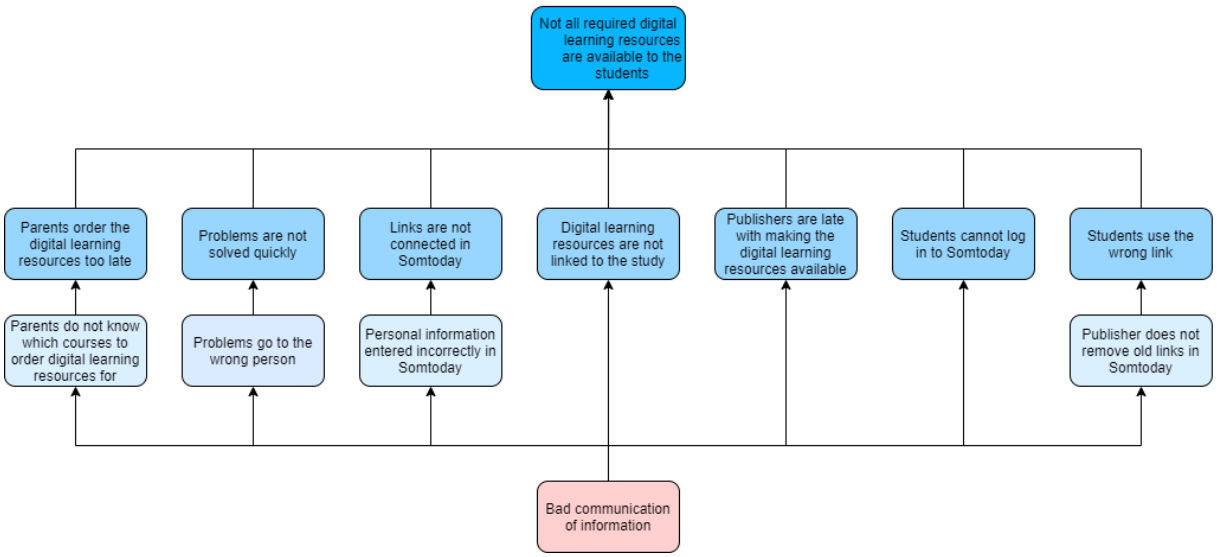

Figure 1.1 Problem cluster

1.6 Research question

The problem analysis indicates that the flow of information between parties in the process of ordering and acquiring the learning resources is not going well. This situation can be solved by the implementation of an information system that facilitates this process and keeps parties in the process informed about what is going on in this process. Details of what the information system should do have not been clarified. Therefore the research question is:

What are the processes to be performed by an information system in order to ensure that the ordering and acquisition of learning resources at Bonhoeffer College are done efficiently?

2 Problem-solving approach

The solution to the problem of Bonhoeffer College is the development and implementation of an information system. The approach of this research to this solution is a contribution to the design of a new information system through the description of the current process, a requirement analysis and flowcharts to describe the process for the new information system. The following sections articulate the approach to solving the problem.

2.1 Theoretical framework

To improve communication and the flow of information, an information system has to be developed. In this system, the communication and flow of information are organized, and users of the system should have clear guidance on where to insert which information and where to find the information they need. To find out how an information system is designed and developed, and to which extend this research can contribute to the design and development of such a system, the following theoretical framework will be used.

2.1.1 Information systems

An information system is a work system that provides and maintains an integrated information flow throughout an organization (Bernus & Schmidt, 1998). It consists of four elements: software, hardware, data, and users (Ryker & Nath, 1998; O'Brien, 2004). The software processes data and tells the hardware what to do and the hardware modulates the interaction with the user (Blum, 2013). The data element is the information that is flowing through the information system and the users are the people that are using the system. The purpose of an information system is to improve the effectiveness and efficiency of the organization by performing business transactions effectively. (Belkin, 1984; Hidayat, Rukmana, & Nurrahman, 2020)

2.1.2 Design science research methodology

For this research, we will use Design Science Research (DSR), which can be used for the design of an IT artifact. By this method of research, the researcher will not only build and apply the artifact but will also gain “knowledge and understanding” (Hevner & Chatterjee, 2010) in this process, about the problem and its solution. To carry out DSR in information systems a framework has been developed: the Design Science Research Methodology (DSRM) (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008). The DSRM contains a series of steps for the creation and evaluation of an artefact:

1. Identification and motivation of the problem
2. Determination of the objectives for the solution
3. Design and development
4. Demonstration
5. Evaluation
6. Communication (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008)

2.1.3 Software Development Lifecycle

The solution to the problem of this research is the design and development of an information system. This will be done according to the Software Development Lifecycle (SDLC). This cycle describes a framework for the design and development of software. The SDLC describes the following five steps: preliminary investigation, system analysis, system design, system implementation, and system maintenance (Othman, Ismail, & Raus, 2009). The software that needs to be designed and developed to solve the problem from this research will be part of the information system. Therefore, the SDLC is in this case an iteration of the DSRM. In both cases the situation is

analysed, objectives are determined, and design, development and implementation are parts of the cycle.

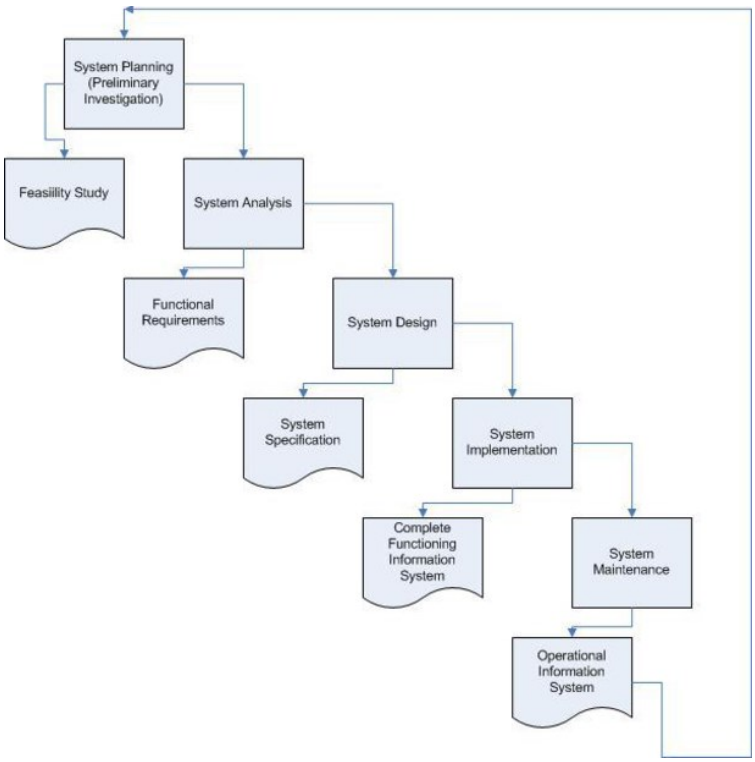

Figure 2.1 Software Development Lifecycle (Othman, Ismail, & Raus, 2009)

The stages of the SDLC (Figure 2.1) will now be further explained.

Preliminary investigation

In this first phase, the current process is analysed. To do this, the problem of the organization is being identified (Hidayat, Rukmana, & Nurrahman, 2020; Jirava, 2004). An 'As-Is' model can be made which is an overview of the business process as it is at the moment (Okawa, Hirabayashi, Kaminishi, & Koizumi, 2011). In addition, opportunities for improvement are analysed and in that way, a solution is specified (Hevner & March, 2003; Laudon & al., 2007). An initial conception of the improvements to processes is needed to inform the design of a solution. (Rosenquist, 1982; Bally, Brittan, & Wagner, 1977).

System analysis

In the second phase the requirements for the information system are being determined (Laudon & al., 2007; Bally, Brittan, & Wagner, 1977). A requirement analysis is conducted and from that, the acceptance criteria are formulated (Hevner & Chatterjee, 2010; Hidayat, Rukmana, & Nurrahman, 2020). A data-flow diagram is made to find points for improvement that can be worked on in the next phase (Hidayat, Rukmana, & Nurrahman, 2020; Jirava, 2004).

System design

The third phase is the system design. In this phase design specifications for the information systems are formulated (Laudon & al., 2007). This means that the organization and the behaviour of the system are drawn out and functions of the system are defined (Rosenquist, 1982; Okawa, Hirabayashi, Kaminishi, & Koizumi, 2011). It includes among others the design of the user interface, which covers the part of the system that handles the input of the user of the system and the output to the display (Jirava, 2004; Myers, 1995). The details of the process of the system should be made

clear by an analysis, just like the access path and the input and output layout (Hidayat, Rukmana, & Nurrahman, 2020; Willow, 2007). Also, files or databases should be designed that will store most of the data in the system (Rosenquist, 1982; Jirava, 2004). In the design phase, 'To-Be' models are made, like a data flow diagram or system flow chart, to describe the flow of data and decisions that are made in the system (Rosenquist, 1982; Willow, 2007).

After the design is completed the information system can be developed, implemented and maintained. The information system can be evaluated and the SDLC can be followed again to further improve the information system.

2.1.4 Business process model

For the 'As-Is' model a Business Process Model (BPM) can be created (Chinosi & Trombetta, 2012). There are different kinds of business process models and different kinds of modelling languages used to create these models. The most common languages are Business Process Modeling Language (BPML) and Unified Modeling Language (UML), which are partly similar (Chinosi & Trombetta, 2012). A number of different kinds of diagrams can be made with either of these modeling languages to map a business process and contribute to the analysis and design of an information system. Business Process Model and Notation (BPMN) is a method to make a Business Process Diagram (BPD) with the use of BPML. As said in (Recker, zur Muehlen, Siau, Erickson, & Indulska, 2009) BPMN is a key instrument for the analysis and design of process-aware information systems. The notation is developed to be readily understandable by all business users (White, 2004). Hence, a BPM that is understandable to all role players in the process can be produced by BPMN.

2.1.5 Contribution of this research to the solution

The problem that Bonhoeffer College has is bad communication of information within the process of ordering and acquiring the learning resources. The solution to this problem is the design and development of an information system. The contribution of this research will be the conceptual design of this solution in the form of flowcharts.

Due to time and resources constraints, this research cannot deliver the full solution in the form of an information system. It will therefore be limited to the initial stages of problem identification, analysis and conceptual design.

This research will provide an analysis and identification of the problem. A BPM model will be made to map the current process, hence this will be the As-Is model. From this model, points of improvement will be analysed in which way an initial concept of the solution is provided. With these activities, the analysis phase is completed.

After that, the requirements of the information system will be analysed and flowcharts are designed to illustrate how the solution should function, which is the To-Be model. These activities form the requirements phase and part of the design phase of the Software Development Life Cycle.

This research will provide a start to solving Bonhoeffer College's problem. The steps described cover part of the SDLC. In order to solve the problem and implement a new information system, further research will have to be done by following the remaining steps of the SDLC.

2.2 Knowledge problems

Additional information is needed in order to perform the planned activities. The following sub-questions have to be answered during the research.

1. *What are the problems with the current processes of ordering and acquiring learning resources?*

   All problems that are occurring within the current processes have to be identified and analysed. Knowledge of these problems is a basis for mapping the current situation and for the requirement analysis. The information can be obtained by interviewing the LRCs from the different locations and application management.

2. *What are the current processes?*
   a. *Which activities have to take place in order for students to have access to their learning resources?*

   To understand and map the current processes, the activities that are performed in these processes have to be known. This information can be found by interviewing parties in the process and looking into the systems that are used.

   b. *How does information flow through the process?*

   The flow of information should be visible in the Business Process Model since this aspect of the process has to be improved. In order to view the communication of information in the model, it should be clear how it flows through the process. This research question can be answered by interviewing involved parties, using the document drawn up by Bonhoeffer College about the process, and looking into the systems that are used within the process.

3. What does the solution look like?
   a. *In what form will the solution be provided?*

   To know what the solution will look like, it should be clear in what form the solution will be provided, hence what this research will deliver. If the form of the solution is clear, an initial solution can be formulated.

   b. *What is the direction of a solution?*

   Based on the information gathered, a direction for a solution can be formulated through inference and deduction. This solution direction helps with the rest of the research because it gives a point of focus and a concept to build the final deliverable around. It will help with making the requirement analysis more complete as well.

   c. *What are the functional requirements of a solution?*

   A requirement analysis has to be done to find out what the requirements are for an improved process. These requirements will help with designing a new process that meets the needs of all the stakeholders and improves efficiency. The requirements can be analysed by answering the following questions:

      i. *What processes should the information system perform?*
      ii. *Which information do the different parties need in the new solution?*
      iii. *What should different users be able to see and do in the new solution?*

   The questions can be researched by using the formulated improvement points, the initial solution, and discussion with parties in the process (e.g. LRCs and head of operations).

4. *What are the improved processes in the solution?*

By using all the information gathered in the research an improved process can be designed. This process should meet all requirements and the needs of the parties involved in the process. It should

also be improved when compared to the current process, at the selected points of improvement. This question will be answered by analysing gathered information from the research and validating ideas with stakeholders from the process.

5. *How will the conceptual solution be validated?*

The conceptual solution should be valid to contribute to a solution that meets the needs of Bonhoeffer College. The solution should solve the problem of bad communication of information within the process and in that way improve the process. This is only possible if the conceptual solution is valid and therefore it should be determined how the conceptual solution will be validated.

2.3 Research design

2.3.1 Type of research

This research is executed according to the Software Development Lifecycle. It covers the first part of this cycle: the analysis, requirements, and part of the design phase. The current situation is described, requirements for the new information system are investigated and the process for the information system is designed. The research is partly descriptive, mostly at the beginning of the research. The problem is investigated and described, and the current process is mapped. This research is also prescriptive, as it contributes to the design of the solution.

2.3.2 Data gathering

Collection of the information is done by interviewing parties in the process: LRCs, application management and Iddink. Additionally, systems used in the process and documents with instructions to students and parents are consulted.

Since the process of ordering and acquisition of learning materials at Bonhoeffer College is not described or mapped, the only way to gather data about the current process is by consulting parties and systems from the process. The model of the current process was validated by the head of operations.

The functional requirements for the process of the new information system are drawn up with input from the LRCs, Iddink, application management and the head of operations. Furthermore, information about Somtoday, the system of Iddink and information systems is used for drawing up the functional requirements.

For the model of the information system the functional requirements are used, as well as input gathered from the LRCs, the head of operations and Iddink.

2.3.3 Limitations

There are a few limitations to my research, which have not allowed me to do my research as well as I could have done otherwise. One of the limitations is caused by COVID-19. Due to the virus, I was not able to speak with any of the parties in person. Interviews had to be done by telephone or by video calling and this is more difficult. It is also the case that some of the parties were very busy because the schools were closed and/or they had to work from home. This caused that they did not have much time for me, and it was more difficult for me to collect information. Also, I was not able to look over the shoulder of people in the process to see what they do and how the systems work. This information had to be gathered by screenshots from people in the process.

Additionally, since I am not able to design and develop an information system, I am not able to deliver a complete solution to the problem that Bonhoeffer College is dealing with. However, this research delivers a plan for a solution that includes flowcharts of an improved process.

The last limitation is caused by the timing of my research. Most of the problems in the process of ordering and acquisition of the learning resources occur at the start of the school year. Since the larger part of this research took place at the end of the school year and even partly in the summer vacation, I was not able to gather information about the problems that occur as well as I could have at the start of the school year. Furthermore, during the summer vacation employees from Bonhoeffer College are less available and therefore it was more difficult to gather information.

2.4 Deliverables

At the end of the research, flowcharts are delivered. These describe the improved process in the solution. This is the basis for the final solution of the problem, which is further design and development of an information system regulating and facilitating the ordering and acquisition of the learning resources at Bonhoeffer College.

3 Analysis of the current situation

3.1 Problem analysis

The first step of the application of the Software Development Lifecycle is the problem analysis. To find a solution it is important to first understand which components make up the problem.

The main problem is that students do not have their digital learning resources available on time. The main cause of this problem is bad communication of information within the process. In Appendix A.1 the problems that are occurring in the process are discussed in more detail. This information is input for mapping the current processes.

3.2 Current processes

A Business Process Model has been made from the current process (Appendix A.2.1). In this model three processes are described: ordering and acquisition of the learning resources, accessing the digital learning resources and solving problems. The activities and flow of information are described for each of the parties. An explanation of the elements in the model can be found in Appendix A.2.2. In the following paragraphs, a description of the current processes is given.

3.2.1 Preparation of the list with learning resources

The process starts in the left upper corner of the Business Process Model (Appendix A.2.1) when the LRCs ask the CSLs for changes in the learning resources for the next school year. The LRC needs a list of the right learning resources from every course section to enter in the system of Iddink before a certain deadline and performs control rounds before submitting the definitive lists.

When Iddink has the definitive list of learning resources, they send a mail to the students that are known to them that the learning resources have to be ordered (around June). Students that are not known to them, since they have not ordered learning resources at Iddink yet, are the ‘new’ students. To inform the new students, the instructions are sent to Bonhoeffer College. The LRCs complete the information and after that, administration sends the information in a letter to the new students. Now all students have the information that will allow them to order the correct learning resources.

Iddink receives the orders and sends the information, of who ordered which learning resources, to Edu-iX. This is a 'content-hub' that gets all the information from Iddink and sends it to the right publishers. The following step, when publishers have received the links, differs between publishers.

3.2.2 Making the digital learning resources available in Somtoday

Two large publishers, Noordhoff and ThiemeMeulenhoff, are delivering directly. This means that they put all the links in Somtoday, which is shown in the ‘publishers’ lane in Appendix A.2.1, but these are not yet coupled to the right years and studies. This has to be done by application management. To do this they need a list from LRCs with the EAN numbers. These numbers correspond to specific learning resources. Application management fills in the right EAN numbers for the right studies and in that way, the right digital learning resources will be coupled to the students.

For the other publishers, Edu-iX takes care of putting the links into Somtoday (‘Edu-iX’ lane in Appendix A.2.1). They are able to directly couple the right links to the students, so Bonhoeffer College does not have to couple them themselves. The links to the required digital learning resources are now in the Somtoday account of the students.

3.2.3 Accessing digital learning resources

To access the digital learning resources the students will have to open Somtoday in a browser (see Appendix A.2.1). In the application of Somtoday, digital learning resources are not available. They sign in on their account and click on the tab 'learning resources'. In this tab, all courses are viewed, with also the option 'General'. There is a division between LiFo (license-folio concept) learning resources, which are learning resources that are offered and priced in a certain way, and other digital learning resources. For the learning resources from the LiFo-model, students only need one license to access the learning material of all years and levels of education. These digital learning resources can be found under 'general'. The other learning resources can be found under the right course.

For both the kennisnet (organisation that supports schools in the professional use of ICT) and the other digital learning resources, students click on the link that is shown on the right side and the system of the publisher will open. The authentication of the students is automatically done by Kennisnet so that they do not have to sign in. For LiFo learning materials, this is always the case. For a few publishers with other digital learning resources (not LiFo), students need a code before they can access the system of the publisher for the first time. This code is either given to them by their teacher, it can be in their books or it can be sent to them by mail.

3.2.4 Problem-solving process

When a student cannot access one or more of their digital learning resources, that problem needs to be solved. To get the problem solved, the student either goes to his or her mentor or directly to the LRC, which is shown at the bottom of the model in Appendix A.2.1. This depends on what is agreed upon at the location. If the mentor establishes that there is some problem, and he or she cannot easily find the cause or solve the problem, the student will be sent through to the LRC of that location.

The LRC first checks if the student opens the digital learning resources in the browser and not in the application. If that is the case, then the cookies and browser history are deleted and the student will try to open the digital learning resources again. If this is still not possible, the LRC checks in the system of Iddink if the student has ordered all the right learning resources and if they are delivered. If not all learning resources have been ordered, the student has to order them and wait for the digital learning resources to be available. If the learning resources have not been delivered, the student probably ordered too late and the digital learning resources may not be available yet. The students will have to wait for them to become available. The problem is then either solved or the LRC continues with the process.

If the student has ordered the digital learning resources and they are delivered, the LRC checks in the system of Somtoday if their accounts of Iddink and Somtoday are coupled. This can be done in consultation with application management. Application management is also able to see which students are correctly coupled and are able to rematch them if needed. If this was not the problem and the accounts were coupled, the LRC can contact either Iddink or publishers. For problems with LiFo-learning resources from the publishers Noordhoff, ThiemeMeulenhoff and Malmberg, the publishers are contacted. For other resources, Iddink is contacted to solve the problem. If the problem can still not be solved, Carmel is contacted. This is the umbrella organisation of Bonhoeffer College and many other (secondary) schools in the Netherlands. In consultation with Carmel, the problem should be solved. This is the final station of the problem-solving process.

4 System analysis

The next step is to make a solution direction as input for the requirement analysis. This will give a first impression of what the solution will look like and which requirements it has. By making a solution direction it can already be decided which processes the system will cover and which information the system and the users should have. This ensures the requirement analysis to be more complete.

4.1 Improvement points

At first, a few improvement points of the current process have been analysed to know what a proposed solution should improve compared to the current process. The communication around the process of creating the new list with learning resources for next year has to be improved. The CSLs and LRCs should be able to efficiently edit and check the list with learning resources without the possibility of miscommunication.

The system should make it possible to add the EAN numbers to Somtoday in an efficient way, instead of by hand. Also, the final list with learning resources should be directly sent to Iddink in the format that they need. After orders have been placed at the website of Iddink, the orders for the suppliers should be created by accumulating the orders placed by the parents, to make this process efficient.

Parents should be able to log into the system of Iddink with their name and students number. The order instructions only have to be shown to the parents at the website of Iddink.

4.2 Proposed solution

This proposed solution describes a possible process of the new information system. For this description, information is used from the model of the current process and the described improvement points. The process has to start with the authentication of the users. Users have to log into the system with their credentials, these credentials are checked, and then the users get access to their dashboards. The dashboard of a user shows the specific information and processes that the user is authorized to see and access. The system needs data about the credentials of the users to authenticate who they are, and about their specific function in the process, to know what they are allowed to see and access.

After the CSLs log in, they have to edit the list with learning resources of their course for the following year. This list will initially contain the same items as the list with learning resources for current schoolyear. The LRCs have to check the lists of their location after the CSLs are done with editing. If there are errors in the list it is marked as incorrect and the CSLs are able to edit it again. The list is edited until it is free from errors and then it becomes the final list.

The EAN numbers from the final list with learning resources are exported to Somtoday. Also, the final list is sent to Iddink so that parents are able to order the right learning resources through their website, after login in with the name of the student and student number. These orders are then integrated into the information system and put in the right format to send to the suppliers. The system needs data with the orders from the parents, as well as a data file with the orders of Bonhoeffer college to send to the suppliers.

5 Processes new information system

The solution of a new information system will be described in the form of flowcharts and a requirement analysis, which is a description of the functional processes that the information system has to execute. The information system will regulate and facilitate the ordering and acquisition of the learning resources by providing a single source of information to the involved parties. The flow of data and information is handled through the information system which will improve the communication of information in the process.

The new information system is an appropriate solution to the problem since it facilitates the processes by having one version of all data and giving overview of the required information in the process. The system will be placed in the LRCs department. Other users that will be authenticated by the system are the CSLs and Iddink. The system administration will be able to control the system. This solution is justified because it is developed from the current processes and will provide an information flow through the process with the system as the only source of information.

The flowcharts with explanations show the users, data entities and processes of a proposed information system.

5.1 Users

System Administration

The system administration is responsible for the information system. They prepare the system with data so that it is ready to be used by the other users. This includes providing the user authentication data.

LRCs

Coordinate the processes around the learning resources. Inform and help teachers and students in accessing the digital learning resources, as well as parents in ordering the learning resources.

CSLs

Each course at each location has its own course section with a CSL. In consultation with the course section, the CSL has to decide which learning resources to use for their course and location next year. He or she has to give this as input to the system so it can be used in other processes.

Iddink

Supplier of the learning resources to Bonhoeffer. Iddink has contact with the publishers, Edu-iX and the LRCs. They organise the ordering and provision of the physical and digital learning resources. Parents can order the learning resources through their website.

Parents

Via the website of Iddink, the parents order the learning resources for their children. They are able to access their account by entering the name of the student and student number.

5.2 Data

User Authentication Data: User Data

Username (key):	The unique username for each user
Password:	The password coupled to the username
Function:	The function of the user (including the course for the CSLs)
Location:	The location at which the user works (only for the LRCs and the CSLs)

New Learning Resources Table: New LR

Item Number (key):	The item number allocated by Bonhoeffer
Course (key):	The name of the course for which the item is used
Schoolyear (key):	The year in which the schoolyear starts that the item is used
EAN Number (key):	Item number of the suppliers
Item Name:	The item title/description
Physical/Digital Indicator:	Indicates whether the item is either physical or digital
Grade:	The number(s) of the grade(s) in which the item is used
Supplier:	The supplier of the item
Correct (y/n):	Indicates whether an item is checked and approved, or incorrect
Date Last Edited:	The last date at which the table is edited and ready to be checked
Date Last Checked:	The last date at which the table is checked

New Learning Resources Allocation Data: New Allocation Data

Item number (key):	The item number allocated by Bonhoeffer
Location (key):	The name of the location of Bonhoeffer College at which the item is used
Course (key):	The name of the course for which the item is used
Schoolyear (key):	The year in which the schoolyear starts that the item is used

Current Learning Resources Table: Current LR

Item Number (key):	The item number allocated by Bonhoeffer
Course (key):	The name of the course for which the item is used
Schoolyear (key):	The year in which the schoolyear starts that the item is used
EAN Number (key):	Item number of the suppliers
Item Name:	The item title/description
Physical/Digital Indicator:	Indicates whether the item is either physical or digital
Grade:	The number(s) of the grade(s) in which the item is used
Supplier:	The supplier of the item
Quantity Ordered:	Quantity ordered of the item
Quantity Supplied:	Quantity supplied of the item

Current Learning Resources Allocation Data: Current Allocation Data

Item number (key):	The item number allocated by Bonhoeffer
Location (key):	The name of the location of Bonhoeffer College at which the item is used
Course (key):	The name of the course for which the item is used
Schoolyear (key):	The year in which the schoolyear starts that the item is used
Quantity Ordered:	Quantity ordered of the item
Quantity Supplied:	Quantity supplied of the item

Order Data from Parents to Bonhoeffer College: Orders from Parents

Order Number (key):	The number of the order
Student Number:	The personal number of the student for whom the order is, allocated by Bonhoeffer College
Student Name:	The name of the student for whom the order is
Item Number:	The item number allocated by Bonhoeffer
Item Name:	The item title/description
Physical/Digital Indicator:	Indicates whether the item is either physical or digital
Location:	The name of the location of Bonhoeffer College at which the item is used
Grade:	The number of the grade in which the item is used
Supplier:	The supplier of the item
EAN Number:	Item number of the suppliers
Order Date:	The date at which the order is placed

Order Data from Bonhoeffer College to the suppliers: Orders to Suppliers

Item Number (key):	The item number allocated by Bonhoeffer
Location (key):	The name of the location of Bonhoeffer College at which the item is used
EAN Number (key):	Item number of the suppliers
Item Name:	The item title/description
Physical/Digital Indicator:	Indicates whether the item is either physical or digital
Quantity:	The quantity of the item required by Bonhoeffer College for that location

5.3 Processes

To describe the processes of the information system, two flowcharts of processes are given: the Login Process and the Learning Resources Allocation Process. The processes shown in the flowcharts are further explained in this section and for each subprocess a description of the functional processes is given. An explanation of the symbols in the flowcharts is given in Figure 5.1.

Part	Description
User	User lane (contains processes runned by this user)
	Process
	Data entity
	Data flow

Figure 5.1 Description of the symbols in the flowcharts

5.3.1 Login process

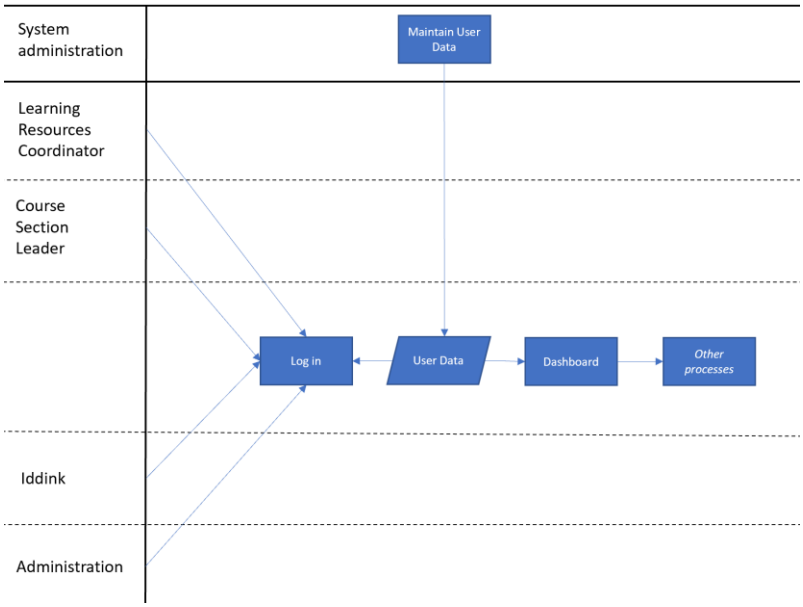

Figure 5.2 Flowchart 1: Login process

In the first step of the process, the users log into the system (Figure 5.2). They enter their credentials and these are then validated against the User Data by the system. The User Data is created by System Administration and contains the fields: username, password, function and location. The user has now entered the system. From the User Data, the system knows which information each user is allowed to see and which processes they are allowed to access. The system shows this information and these processes at the dashboard of the user. If the user selects a process from the dashboard, the system shows the input data of this process to that user.

Maintain User Data

User:	System Administration
Input data:	User authentication data
Process:	Validate and store input data.
Output data:	The updated User Data.

Log in

Users:	LRCs, CSLs and Iddink
Input data:	User access credentials, User Data
Process:	Every user is required to enter their user access credentials and these are validated against the User Data: Username and the User Data: Password.
Output data:	The users are granted access to the Dashboard process and to other specific processes.

Dashboard

Users:	LRCs, CSLs and Iddink
Input data:	User Data, year and selected process
Process:	From the User Data: function and User Data: location it is determined which information and processes the user has access to. For the LRCs and CSLs these are only information and processes of their location and for the CSLs also only information and processes of their course.
Output data:	The dashboard of the user contains the information that the user is authorized to see of the year given as input, and the processes the user is allowed to access. The user selects the process that he or she wants to access.

5.3.2 Learning Resources Allocation Process

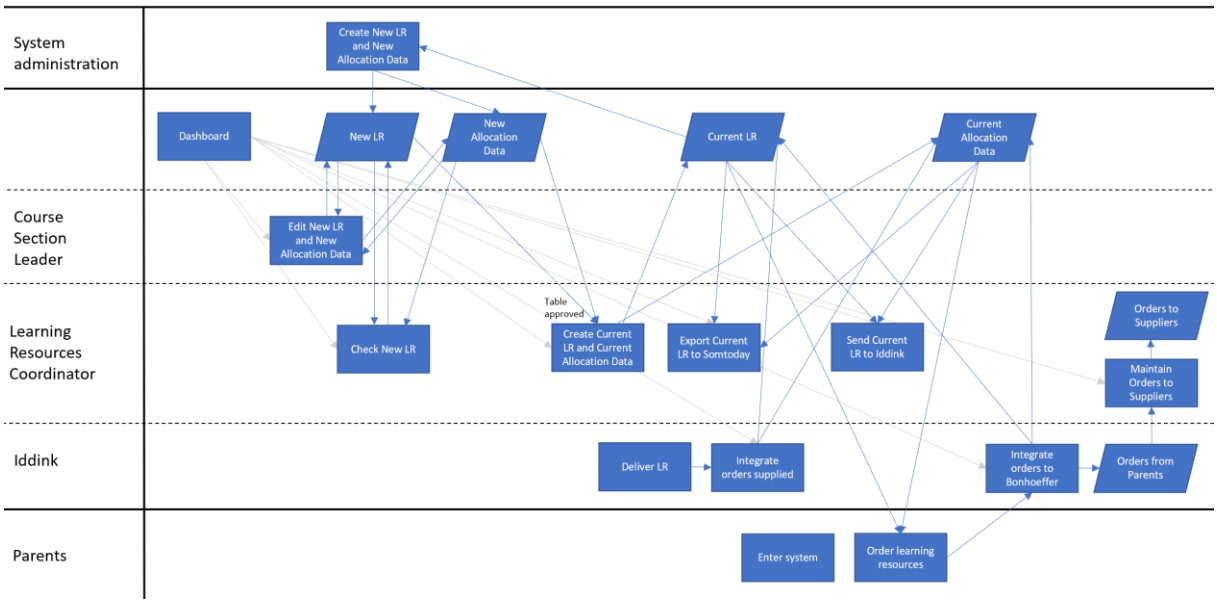

Figure 5.3 Flowchart 2: Learning Resources Allocation Process

Figure 5.3 shows the Learning Resources Allocation Process. This process is shown and explained in parts below.

5.3.2.1 Creation New LR and New Allocation Data

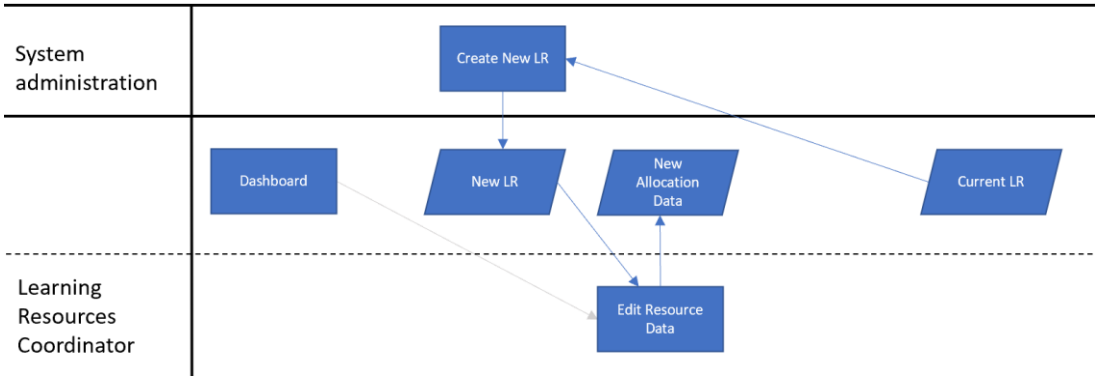

Figure 5.4 Flowchart 2: Learning Resources Allocation Process: Part 1

In Figure 5.4 can be seen that from the list with learning resources of current schoolyear, the list with learning resources for next schoolyear is created: the New LR. System Administration, therefore, uses the Current LR and Current Allocation Data, as input for this process. The Current LR contains an item number, course, schoolyear, EAN number, item name, physical/digital indicator, grade, supplier, quantity ordered and quantity supplied. The Current Allocation Data contains an item number, location, course, schoolyear, quantity ordered and quantity supplied. System administration increases the schoolyear by one and sets the quantity values to zero. Then the New LR of each location for next schoolyear is created and ready to be edited by the CSLs. At the same time, the New Allocation Data records are updated by adding or deleting locations. The New Allocation Data contains at least one record of each record in the New LR.

<u>Create New LR and New Allocation Data</u>

Users:	System Administration
Input data:	Current LR and Current Allocation Data
Process:	System Administration creates the New LR for each location by increasing the field Current LR: Schoolyear by one and setting the values of Current LR: Quantity Ordered and Current LR: Quantity Supplied to zero. The New Allocation Data records are updated at the same time by adding or deleting locations.
Output data:	The New LR for each location, as well as the New Allocation Data, are created containing the items from the Current LR of that location and the Current Allocation Data.

5.3.2.2 Edit and check of New LR and New Allocation Data

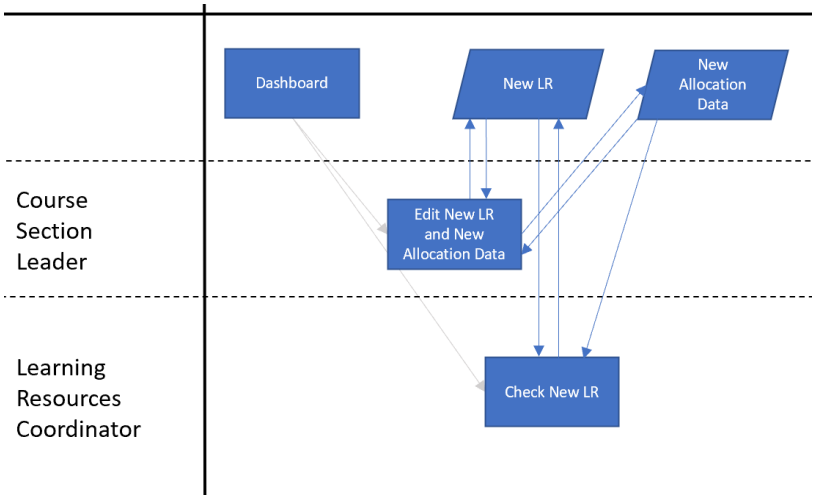

Figure 5.5 Flowchart 2: Learning Resources Allocation Process: Part 2

The CSLs have access to the New LR and New Allocation Data of their location and course. They can add and remove learning resources to make it a list of the learning resources that they want the students to use next schoolyear (see Figure 5.5). If they are done, the New LR: Date Last Edited is changed to current date. The LRCs are now able to check the New LR and New Allocation Data. If there are errors in the list, the field New LR: Correct (y/n) of the incorrect items gets the value 'no', the CSLs will be able to edit again. Also, the New LR: Date Last Checked is changed to current date. The system will check that all records are correct and report on any incorrect records. Once all values of the New LR: Correct (y/n) have the value 'yes', the list is correct, and the LRCs are able to create the final list.

Edit New LR

Users:	CSLs
Input data:	New LR and New Allocation Data
Process:	When the New LR is created or the New LR: Date Last Checked has been updated, the CSLs add and remove items of their course, including the EAN numbers, from the New LR of their location and the New Allocation Data to make it a list of learning resources for next year. The system only shows the records of items that are incorrect or not checked yet. When the list is ready to be checked, the New LR: Date Last Edited is changed to current date.
Output data:	The edited New LR and New Allocation Data.

Check New LR

Users:	LRCs
Input data:	New LR, New Allocation Data and user changes
Process:	The LRCs check the items in the New LR table of their location and their allocations. If an item of the list is correct, the New LR: Correct (y/n) is set to 'yes' by the LRC. Otherwise, they set the value of New LR: Correct (y/n) to 'no'. The New LR: Date Last Checked is then changed to current date. The Current LR and Current Allocation Data process will check that all records are correct and report on any incorrect records.
Output data:	The updated New LR and New Allocation Data records.

5.3.2.3 Creation Current LR and Current Allocation Data

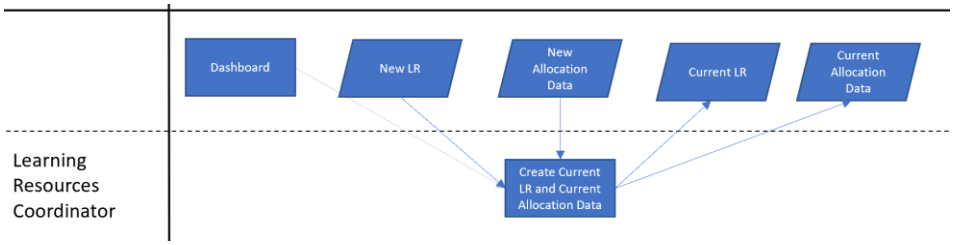

Figure 5.6 Flowchart 2: Learning Resources Allocation Process: Part 3

If the lists of a location are all marked as 'correct', the LRC uses these lists for the next process (see Figure 5.6). They remove the values of the correct indicator, the date last edited and the date last checked. Also, the Current Allocation Data is created from the data of the New Allocation Data. The Current LR and Current Allocation Data can then be used for other processes.

Create Current LR and Current Allocation Data

Users:	LRCs
Input data:	New LR and New Allocation Data
Process:	As soon as no records are shown by the system, hence all records are correct, the values of the fields New LR: Correct (y/n) and New LR: Date Last Checked are removed by the LRCs. The records from the New Allocation Data are added to the Current Allocation Data.
Output data:	The Current LR and Current Allocation Data with learning resources for next schoolyear are created.

5.3.2.4 Export and send Current LR and Current Allocation Data

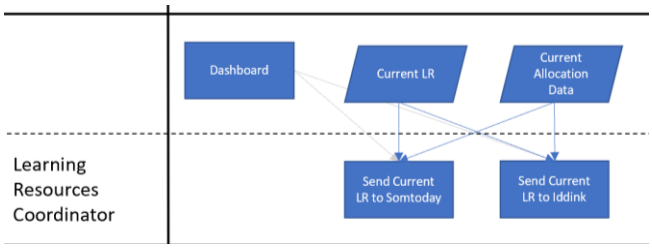

Figure 5.7 Flowchart 2: Learning Resources Allocation Process: Part 4

The LRCs use both the Current LR and the Current Allocation Data to make the Current LR accessible in Somtoday, as shown in Figure 5.7. To do this, a file is exported in the format required by Somtoday. The LRCs also use both the Current LR and Current Allocation Data to send this information to Iddink. The keys to couple the new information system to the system of Iddink are the item number and EAN number. Iddink needs the learning resources information to make sure parents order the right learning resources.

Export Current LR to Somtoday

Users:	LRCs
Input data:	Current LR and Current Allocation Data
Process:	After the Current LR and the Current Allocation Data of a location are created, these data files, including Current LR: EAN numbers, are made accessible to Somtoday viewers, by exporting the files to Somtoday in the format required by their system.
Output data:	The Current LR: EAN numbers are available in Somtoday.

Send Current LR to Iddink

Users: LRCs and Iddink

Input data: Current LR and Current Allocation Data

Process: The LRCs send the Current LR and the Current Allocation Data of their location to Iddink after both data entities are edited and checked to ensure they are correct. The Current LR: Item Number and Current LR: EAN number are used as keys to send this data to Iddink.

Output data: The Current LR and Current Allocation Data are added in the system of Iddink.

5.3.2.5 Placing orders

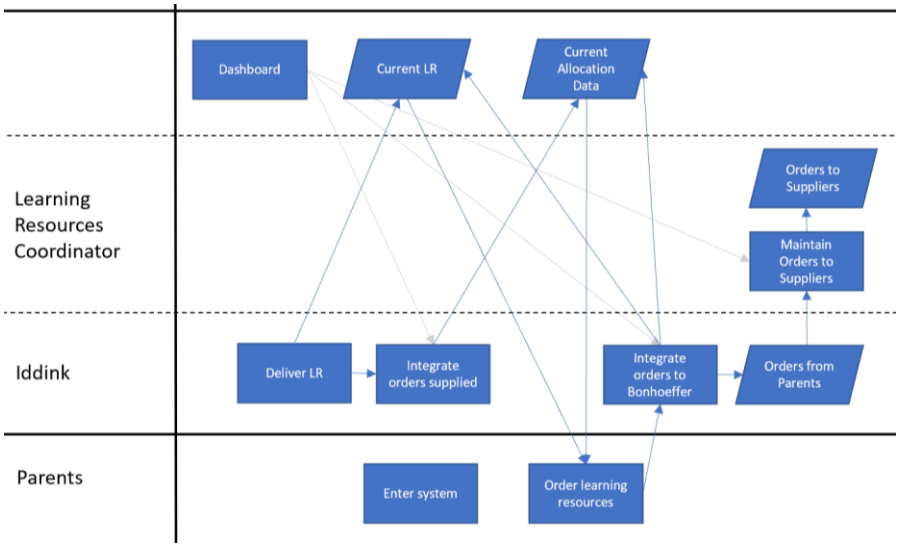

Figure 5.8 Flowchart 2: Learning Resources Allocation Process: Part 5

As soon as parents have ordered their learning resources, Iddink integrates the Orders from Parents to the new information system (Figure 5.8). This data is now available to the LRCs and contains at least the following fields: order number, student number, student name, item number, item name, physical/digital indicator, location, grade, Supplier, EAN number and order date. From this data, the Orders to Suppliers is created by the system. This order file contains the fields: item number, location, EAN number, item name, physical/digital indicator and quantity.

Enter system

Users: Parents

Input data: Login data

Process: The Parents will use the login details on the website of Iddink to enter the system. They are able to log in with the name of the student and their student number. Order instructions are given at the website of Iddink.

Output data: The Parents are able to order the learning resources at the website of Iddink.

Order learning resources

Users: Parents

Input data: Current LR and Current Allocation Data

Process: The Parents order the learning resources that the students need according to the Current LR via the website of Iddink. The Current Allocation Data is used to validate the order. It is checked which learning resources the students need. Once the order is validated, it is added to the data in the system of Iddink.

Output data: The order is added in the system of Iddink.

Integrate orders to Bonhoeffer

Users: Iddink

Input data: Orders from Parents

Process: The imported data file with orders placed in the system of Iddink is used to update the Orders from Parents data file in the system Bonhoeffer. Only records that have not been previously integrated, will be integrated into the system of Bonhoeffer. The Current LR: Quantity Ordered and Current Allocation Data: Quantity Ordered are updated according to the Orders from Parents. When an item is ordered, one is added to the Current LR: Quantity Ordered and Current Allocation Data: Quantity Ordered of that item. If the Orders from Parents: Student Number, Orders from Parents: Schoolyear and Orders from Parents: Item Number of multiple records are the same, these records are merged.

Output data: The data entity 'Orders from Parents' is integrated and can be used to create the Orders to Suppliers. The Current LR and Current Allocation Data are updated.

Maintain Orders to Suppliers

Users: LRCs

Input data: Orders from Parents

Process: The Orders from Parents are added to the Orders to Suppliers by the system as new items and/or by increasing the Orders to Suppliers: Quantity of existing items.

Output data: The Orders to Suppliers are updated.

Integrate orders supplied

Users: Iddink

Input data: Order supplied

Process: From the delivery confirmations, Iddink has the information about which of their orders are delivered to the students. Each time an item is delivered, the Current LR: Quantity Supplied and Current Allocation Data: Quantity Supplied for that item are increased by one. The Current LR and Current Allocation Data are imported from the system of Iddink and the records of this data are integrated into the system of Bonhoeffer.

Output data: The Current LR and Current Allocation Data are updated.

6 Conclusion and recommendations

6.1 Conclusion

The aim of this research was to answer the following research question:

What are the processes to be performed by an information system in order to ensure that the ordering and acquisition of learning resources at Bonhoeffer College are done efficiently?

To do this, a start has been made in designing an information system that will regulate and facilitate this process. The final product of this research are flowcharts and accompanying explanations of the new processes with the information system.

The new information system provides a solution to the poor communication of information by providing one source of each data entity. By having only one version of data no miscommunication of this data can occur. The Software Development Lifecycle is used to make a design for the information system. By the execution of the first three steps of this cycle (preliminary investigation, system analysis and system design) a conceptual solution is provided to the problem of bad communication of information within the process of ordering and acquiring learning resources.

From the preliminary investigation and system analysis, it became clear which processes needed to be improved to be more efficient. The preparation of the list of learning resources for next year needed one source of the data to prevent miscommunication of the information. This same data entity can then be used for other processes. It should be possible to couple the system to the system of Iddink and Somtoday for an efficient exchange of information. A clear order for the suppliers should be created from the orders that parents place on the website of Iddink and, lastly, the order instructions should be accessible by the parents at the website of Iddink and they should be able to login at this website with their name and student number.

This research adds value since its solution would improve the efficiency in the ordering and acquisition of the learning resources at Bonhoeffer College. The proposed information system achieves efficiency by using one version of the list with learning resources, namely the Current LR. No errors can occur in the list and therefore no problems. Also, when editing or checking the list with learning resources, the focus is on the items that need work, which are the incorrect items. No time is wasted on double-checking items that were already correct. Efficiency is achieved by making the EAN numbers accessible to Somtoday viewers, as well. Instead of adding the EAN numbers to Somtoday by hand, the data is exported from the information system to Somtoday. Order instructions should not be sent to the new students via the post anymore. Students have to be able to log into the system of Iddink with their name and student number, and see the order instructions in this system, which is a large efficiency gain. After parents have ordered, the Orders from Parents data file is created. Merging the records with the same student number, schoolyear and item number makes the process more efficient. The last efficiency gain can be found in the tracking of the orders supplied. Data is available in the information system about the amount ordered of each item, and the amount supplied.

6.2 Recommendations

To improve the communication of information within the process, the information system will have to be further designed and developed, and should eventually be implemented. This research will form the basis for the development of the system.

The information system can be used for more processes within Bonhoeffer College. It has the potential to be a tool that controls the communication of information between employees of

Bonhoeffer College and other parties involved in their processes. The system could also be an example for other high schools to regulate and facilitate the communication of information within their processes.

6.3 Reflection of results

The result of this research shows an information system that will take control over part of the communication of information within the processes of ordering and acquiring the learning resources. This is based on the model of current processes and therefore focussing on the main tasks. The information system can be further extended by letting it control the communication of information in more processes than are viewed in the model and discussed in the requirement analysis.

Another 'alternative' for a solution is by solving the root problem for part of the problems, which is a choice of Carmel. Carmel is the umbrella organisation of Bonhoeffer College and other high schools in the Netherlands. They make agreements on the learning resources, and all schools, including Bonhoeffer College, have to follow these agreements. One of them is that, for learning resources of Noordhoff and ThiemeMeulenhoff (and originally Malmberg), the publishers deliver directly to the schools. This means that no distributor is involved in this process, hence Iddink cannot be involved. The digital learning resources have to be delivered in bulk to the schools and the schools have to make sure that the resources are coupled to the right classes or students. Therefore, the learning resources have to send the EAN numbers to application management, who have to make sure the learning resources are correctly coupled to the Somtoday accounts of the students.

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Appendix A: Current situation

A.1 Problem analysis

A.1.1 Ordering process

At the beginning of the process, parents have to order the learning resources (both paper books and digital learning resources). This ordering process takes place within the system of the organisation Iddink and takes a lot of steps where things may go wrong. Parents may fill in the wrong school code or fill in their personal information in the wrong way, which causes Somtoday to not recognise the students and then the coupling between the system of Iddink and Somtoday for this student will fail. This may have different causes: the instructions about which information to fill in are not communicated well enough to the parents, they cannot see that they have made a mistake after filling in the information, or they did not read the instruction (information) well enough. These are all issues concerning the communication of information.

Some of the parents do not know which learning resources to order since the student does not remember which courses he or she chose and they cannot find this information anywhere. Parents also get confused when they see products of Iddink during the ordering process, from which they do not know if they are necessary to order ('recommended' products). These problems may be the cause of parents ordering the learning resources too late, along with the possible causes that parents forget, procrastinate, or do not know that they have to order the learning resources. All these problems occur because parents either do not have the right information, the information is not communicated well enough or they do nothing with the given information.

A.1.2 Acquisition process

If the digital learning resources are ordered, the following problem is that some students cannot reach their resources, which can have different causes. Students may try to reach their learning resources in the app of Somtoday. In the app the learning resources cannot be found; they have to open Somtoday in a browser. In the browser, however, present cookies or browser history may prevent students to reach their digital learning materials. It can also be the case that there are multiple links in Somtoday to learning resources from the same course. Students have to click on the right link to open the correct learning resources for that specific course, but this does not always happen. These problems are due to lack of knowledge, caused by bad communication of information. To solve the problems, students go to their mentor or to the LRC of their location.

A.1.3 Problem-solving process

The LRCs do not always have enough information to solve the problems that are reported to them. They have no task description concerning the digital learning resources and have to figure out what to do with problems by themselves. The problems differ at each of the locations, just like the approaches to solve the problems. There is no general guideline on how to handle problems and what to do as a LRC to solve the problems efficiently. Also, there is little communication between the locations which causes each LRC to find a solution for the same problem and thereby waste a lot of time.

It does not help that there is no overview of the process. This causes a lack of knowledge by parties in the process. Within the process, there is a lack of information about who has the knowledge to solve which problems. Problems are consequently pushed around between different parties until someone is able to solve it. As a result, it can take a lot of time to solve certain problems and it would, therefore, be better to know all the problems that are occurring at the start of the year. The LRCs have tried to make sure that all students check at the start of the year if they can access all of

their digital learning resources. However, in practice, this is hard to realise and too many students discover only later in the year that they cannot access one or more of their digital learning resources.

A.1.4 External parties

External parties such as Iddink and publishers play an important role in the process, but also cause some problems. One of the problems that has occurred is that publishers forget to remove old links to the digital learning resources. Students are either not able to access their digital learning resources via this link or the link is removed later in the year, which causes students to not being able to access their digital learning resources after a certain time. It has also occurred that either the publishers or Iddink were late with making the resources available. This sometimes was caused by late changes on the list with learning resources.

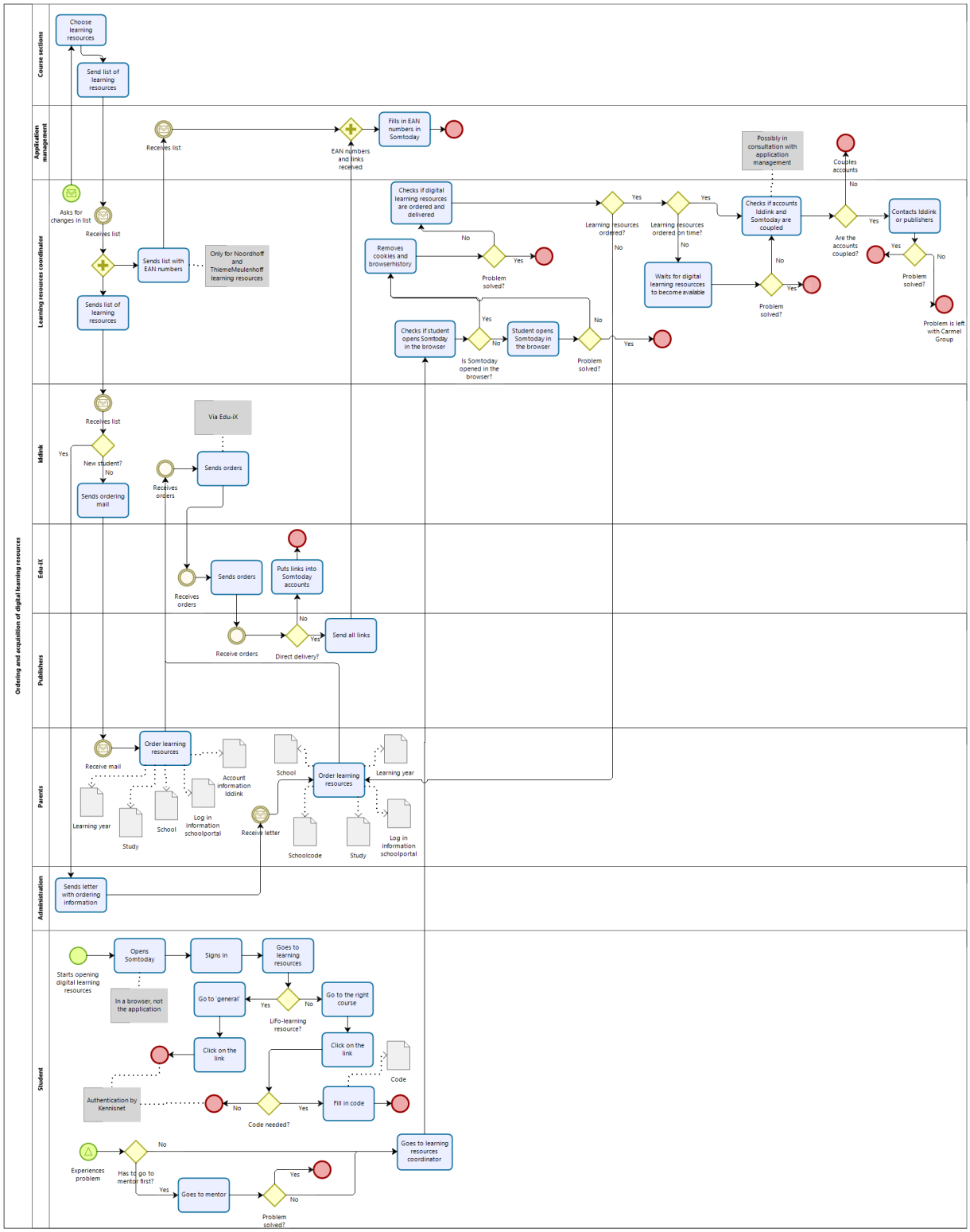
Publishers are causing another problem with the different methods that they are using to access their digital learning resources. These different methods are a lot of extra information the students got to have to be able to access their resources. This information is not communicated to them in a clear or easily understandable way. Hence, this too causes problems in the process. The publishers (and other parties at the start of the process) do not think enough about the workplace and problems that could occur when the digital learning resources have to be used by students.

A.1.5 Main cause

The discussed problems have a common causative factor, which is bad communication of information. Parties in the process are not communicating relevant information to each other timeously, which results in lack of knowledge and confusion, and therefore problems.

A.2 Current processes

A.2.1 Model of current processes



A.2.2 Explanation model of current processes

The BPMN knows four basic categories of elements, which are: flow objects, connecting objects, swimlanes and artifacts.

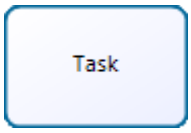
The flow objects are either events, activities or gateways. These are actions that determine how the process behaves. The connecting objects can connect objects to each other, of these are three different kinds: sequence flow, message flow and association. In the swimlanes certain objects can be grouped. In the model this is used for grouping the objects that belong to a party. The artifacts, which can be data objects, groups or annotations, provide extra information in the model .

In the model are three processes mapped:

- The ordering and acquisition of the digital learning resources
- Accessing of the digital learning resources by a student
- Problem-solving if a student cannot reach their digital learning resources

All three processes start with a green circle and end at different places with red circles. These red circles mean that the process stops there. For example, in the problem-solving process this means that the problem is solved. At the left side the parties of the process are viewed.

Meaning of the objects:



Task. Show an activity of one of the parties.

An exclusive gateway. The flow diverges in multiple ways, but it only continues in one of these ways, depending on the condition.

A parallel gateway. The gateway continues in multiple outgoing flows or, if multiple flows are converging through the gateway, waits for all flows to arrive before it continues with the outgoing flow.

Start event. Starts the process.

Message start event. Process is triggered to start by a message.

Signal start event. Process is triggered to start by a signal from another process.

Event. Shows something happening.

Message catch event. Shows a mail being received.

End event. Stops that process flow.

Message end event. Shows that a message is send when the process stops.

Annotation. Gives extra information.

Data object. Shows the required data.

The different objects are connected by connected objects. The model will not match exactly practice. Only the essentials are mapped.