Jarmo Häivälä

Requirements for a resource management system

Metropolia

Preface

I wish to give my sincere thanks to Dr. Thomas Rohweder and to Director Veikko Suihko-nen who guided me through this thesis. Thank you also to Recion's great personnel for interviews and multitude of inputs which all helped me on the way. Thanks to Sonja Ho-lappa for language check of my work. Thanks to excellent Metropolia faculty and to my fellow students for great teamwork and great moments.

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Abstract

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Recion uses a resource management system which is obsolete and need to be replaced. The objective of this thesis is to find the best method for Recion to create software requirements and a guideline to follow through the software development process.

The study was based on the stakeholder interviews to carry out current state analysis and to validate findings. Literature sources were used to find best practice for creating software requirements and a guideline for the software project. As an outcome this work revealed critical requirements for the software and a guideline to follow.

Recion can use this work to start a procurement process for a new resource management system.

Keywords: Software, Requirements, Resource Management, Industrial Piping

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Appendices

1 Introduction

This thesis is about requirements for a resource management software which is crucial to an industrial piping company Recion. The Current software is obsolete and needs to be replaced as soon as possible.

For an industrial company with no substantial software development know-how, it is very risky to start developing a new software solution. This is the reason for this thesis to research the best methods for creating requirements for a new software. Recion also needs a guideline how to go through the process of software procurement. Without proper requirements and guideline through software procurement, the expenses and the time needed to complete the project may multiply.

1.1 Business Context

Recion has niche expertise in high-pressure piping solutions. Recion does high-pressure piping installations and turn-around projects. Customers include but are not limited to industrial plants, powerplants, nuclear power plants, pulp-mills, refineries, and factories. Recion provides project management and piping engineering planning services, fabrication and surface treatment and carry out mechanical installations. Fabrication and pre-fabrication take place at Recion's workshop at Ylivieska. Recion also builds piping for new plants. This work is done by the installation unit.

Recion has three actual units which provide products or services to our customers. The-units are engineering design unit, fabrication workshop and installation unit.

Currently only the installation unit has a resource coordination person: resource manager who is the head of the installation unit and who coordinates 60 installation personnel from project to project.

1.2 Business Challenge, Objective and Outcome

Business Challenge

Currently Recion's 60 installation personnel (welders and fitters mostly) are coordinated using a resource management system which is built on obsolete Lotus Notes platform. The system is called Kyky-Set. The development has started in early 2000 and has found its current form in 2010. The development was done mostly by a single person who has been retired since 2015. In Recion there are two persons who can update the data and

keep the system running but that is all. There is also the issue that Kyky-Set's interface is very difficult to use by modern standards. Also, its features are hard to find and some of the critical features do not work anymore. The current system, called Kyky-Set needs to be replaced as soon as possible.

Accordingly, the objective of this thesis is to create requirements for a new resource management system. Once the requirements are specified, they will be help Recion to control the software procurement process and lower the costs of the software.

1.3 Thesis Outline

This thesis has 7 sections starting from Section 1 introducing the topic and objective. Section 2 describes the research and data collection methods and Section 3 explains the Current State Analysis which was carried out to identify challenges related to the resourcing process. Section 4 describes Finding the Best practice on software requirement specification and Section 5 is about Building Proposal on Resource management system for Recion. Section 6 explains the Validation of the Proposal and summarizes the final proposal. Finally, the section 7 describes the Conclusions of this thesis.

1.4 Key concepts

Table 1 below depicts the key concepts of this work.

Resource management in Recion	A process to allocate human resources such as welders, fitters, installation supervisors, quality personnel to projects. Also reports the resource allocation and demand forecast to the board of directors.
Resource manager	A position which serves as supervisor for welders, fitters and installation supervisors. Owner of the resource management process.

A resource	A human resource. In Recion's case usually a project manager, site manager, quality expert, installation supervisor, pipe welder or pipe fitter. Resources are managed and allocated using a software called Kyky-set, a resource management system.
Welder, a pipe welder or an industrial pipewelder	An industrial pipe welder is a professional who has skill to weld high-pressure pipes in difficult conditions. These are but not limited to: Refineries, pulp mills, power plants and nuclear power plants. A professional who is very hard to replace.
Fitter, pipe fitter or an industrial pipe fitter	An industrial pipe fitter is a professional who has skill to haul very heavy components to difficult places for installment. Fits pipes for welding. A pipe fitter usually leads the work of a welder and fitter pair or several pairs.
Kyky-set	Recion's current resource management software.
Personnel cards in Kyky-set	An employee database of employee work related information. Any person working in Recion has a personnel card. This card can be linked to a project.
Project information card in Kyky-set	All the basic level of information about a Recion's project are here. Personnel cards linked to project information card make up the project resourcing.
Call to work feature	A message which is send to employee

	that is an invitation/order to work at a project. Contains basic information about the project.
Työmaan pelisäännöt-document	A document which is sent to employees that contain all the information a worker needs to know about the project.

The next section describes the research method and material.

2 Method and Material

This section describes the research approach, data collection and analysis methods used in this study. It includes a research design which shows the different stages and the logic of this study.

2.1 Research Approach

The aim of this research is to understand the importance of software requirements in software procurement process and to find the right way for Recion to create them.

The research is conducted by searching viable literary sources for software requirements and software procurement process. The aim is to find best possible method for Recion for creating software requirements.

The software requirements will be the center of this thesis, several methods will be studied and compared. Since there is no software development expertise in Recion, this factor must be considered.

It is common knowledge that software procurement usually fails because lack of expertise in buyer organization. Therefore, one goal is to find a comprehensive guideline in literary sources that Recion can follow through the procurement process.

2.2   Research Design
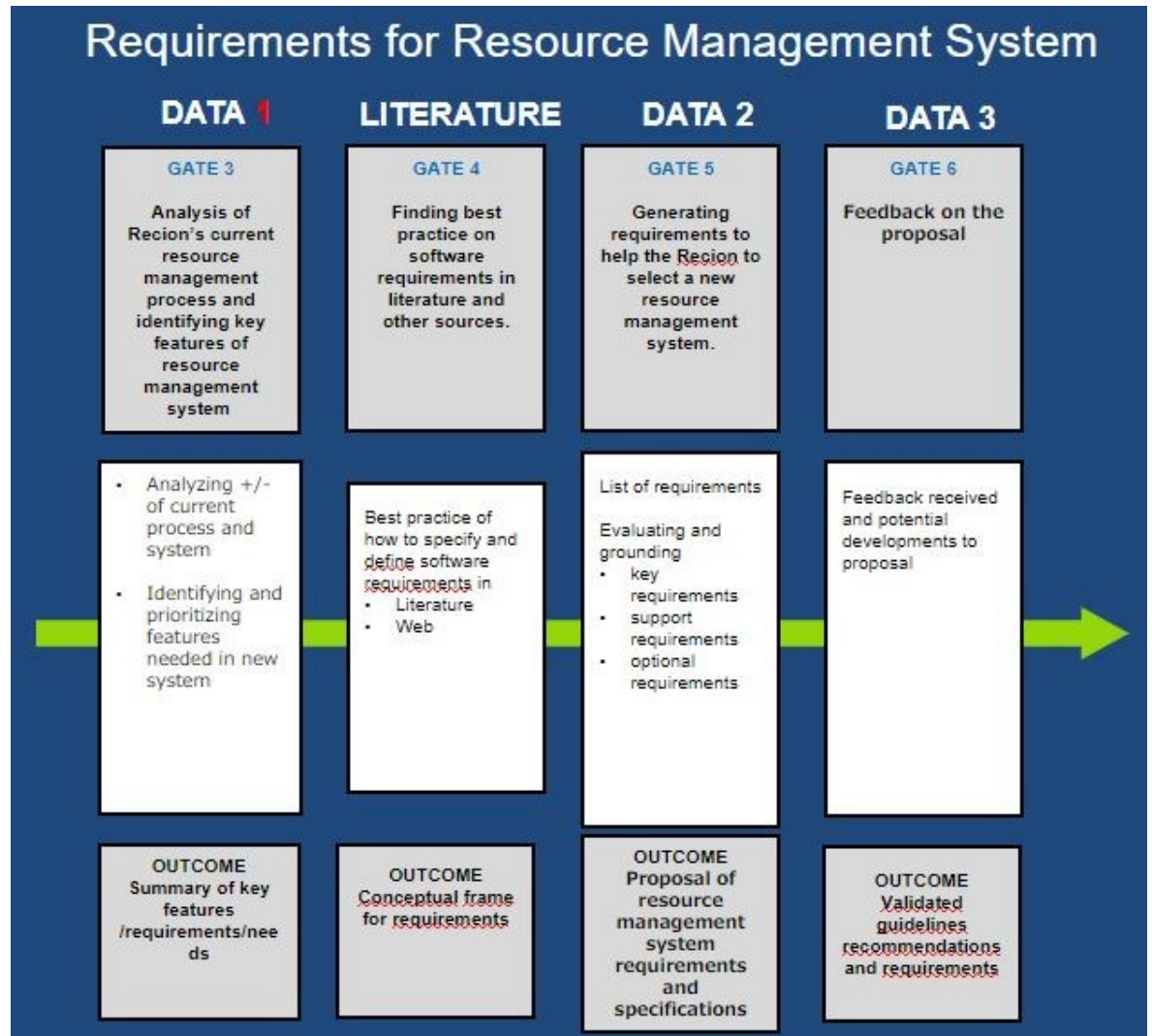
Figure 1: research design of this study.

As shown in Figure 1, in Data 1 stage a current state analysis is conducted by analyzing the resource management process and then finding the key features and requirements needed to support the resource management process. This is done by interviews with stakeholders.

Then literary sources are used to find best practice for creating software requirements. Then a conceptual frame is created how the requirements will be created. Using current state analysis and literary sources a conceptual frame for requirements is created.

In Data 2 stage a proposal for the software requirements is generated. This proposal is grounded on information found in Data 1 stage.

Next the Data 3 stage is when the proposal receives feedback from the process stakeholders. The suggestions are considered and after the developments on the proposal the final proposal is going to be validated by the stakeholders. In this stage the final list of requirements is ready for Recion software procurement. Also, an objective is to present a viable guideline to help through the procurement process.

2.3   Data Collection and Analysis

In this study a variety of data sources is used. In data 1 stage a workshop and interviews with stakeholders begins the process of data collection. Then the current resource process is analyzed and the required features which are in current resource management system.

Data 1 stage is followed by literary research for best practice for software requirements generation and for guideline to guide through procurement process.

After literary research a best practice is used to create initial proposal for software requirements, and it is called Data 2 stage.

Data 2 is then presented to and evaluated by the stakeholders and their input is considered and developed into a final proposal. The final proposal and guideline is then recorded as Data 3 stage which is the result of this research.

Data Stage	Method	Source
Data 1, Current state analysis	Interviews, a workshop and analyzing current resource process and resource management system and minimum requirements for new system	Stakeholders: current and former resource managers, Kyky-set
Literature	Research best practice for software requirements and for software procurement guideline	Literary and internet sources
Data 2, Generating software requirements	Following best practice from literary sources and current state analysis, generate software requirements proposal for stakeholders	Combine current state analysis and best practice to find what requirements are needed and propose findings to stakeholders

Data 3, feedback on the proposal	A workshop with stakeholders for feedback on the proposal. Supplement with interviews is necessary.	Stakeholders, and Data 2 proposal

Table 2 above shows the general research plan.

Table 3. Details of interviews, workshops and discussions in Data1-3.

	Participants / role	Data type	Topic, description	Date, length	Documented as
	Data 1, for the Current state analysis (Section 3)				
1	Respondent 1: Director of pre-fabrication	Face to face Interview	Recion project resourcing process	Jan 2021, 1 hour	Field notes
2	Respondent 2: Quality engineer, Notes admin	Telephone call	Lotus notes support, strengths, features and challenges	Feb 2021, 30min	Field notes
3	Respondent 3: Sales manager	Face-to-face Interview	Interview about current process based on the Recion's sales process and resources availability reporting	Feb 2021, 30min	Field notes
4	Respondent 4: Procurement engineer (former resource manager)	Field notes	Challenges and human aspect of resourcing	Feb 2021, 60min	Field notes
5	Respondent 5: Resource manager	Online meeting	Current resourcing process using kyky-set and challenges	Dec 2021, 60min	Field notes and video recording
	Data 2, for Proposal building (Section 5)				
7	Director of Prefabrication	Phone call	Proposal building	April 2022	Field notes
8	Resource manager	Phone call	Proposal building	August 2022	Field notes
	Data 3, from Validation (Section 6)				
9	Director of pre-fabrication	Final presentation	Validation, evaluation of the Proposal	November 2022	Field notes and recording

As seen in Table 3, data for this project was collected in three rounds. The first round (Data 1) was conducted for the current state analysis to reveal the challenges in resource management process. The data collection round 1 included face-to-face interviews and phone calls and a online meeting.

In the next round, Data 2 was collected to gather suggestions from the stakeholders for developing the proposal.

The final data was collected when receiving feedback for the proposal from a Recion's stakeholder who commented on the final presentation.

In this study, the interviews made the primary method of data collection. The interviews were conducted as semi-structured, face-to-face interviews and phone calls. The questions were about current state of the resourcing process and what the current resource management system lacked.

The next section discusses the findings of the current state analysis.

3   Current State Analysis

This section describes the current state analysis of the resource management system, Kyky-Set, which is currently in use. First there is an overview of the current state analysis, then step by step description of the resourcing process using Kyky-Set. Also, some of the challenges involving resource management and planning are presented in sections 3.2.1 - 3.2.10.

3.1   Overview of the Current State Analysis Stage

The results of this analysis are derived from the main user of the Kyky-Set resource management system, the resource manager. Additionally, the Director of pre-fabrication and procurement engineer, project manager and the workforce resource themselves and the author of this thesis contributed to this data collection. All the mentioned have years of experience with Kyky-set from their own perspective. Discussions were conducted through online meetings and phone calls. To extract most of the information, the discussions were quite private and informal because the subject carries a substantial amount of emotional charge. Also, most of the people want to remain unnamed so they are referred only by their position in the company.

The first step was to analyze the current process of the resourcing. This was a little bit surprising since when most of the affecting factors are identified and even drawn of the process map it becomes evident that there is too much interference with the process (sections 3.2.1 - 3.2.10).

The second step was to interview with the former and current stakeholders of the resourcing process and record a video for the use of this thesis for further analysis.

The third step was to try to make an understandable chronological presentation of this unchronological process. This was a challenge since workers may enter and leave a project several times before the project is completed. To combat this, the process is very simplified for rhetorical purposes: it starts with preliminary resource planning and ends with assigning the worker to another project or time off work.

3.2 Current state analysis of resourcing process

The current resourcing process in Recion is at its core as follows. Recion sells a project, project management request for human resources based on initial project analysis and project plans. Then Resource manager look for available qualified resources from Recion's resources pool and from sub-contractors or rental workers if needed. Then a resource plan is formed based on these human resources.

The resource manager presents the resource plan for the project and then the project will accept the plan or request changes in resourcing. After the project has accepted the resource plan the Resource manager will inform the personnel (if not done at planning stage) about the project and schedule. Resource manager will send a Call to work-message which serves as an information document for worker and a proof of procedure for resource managers lawful performance. Personnel will travel to site and work. After the project resource manager will conduct a resourcing process for the personnel for next project, vacation or a fixed term lay-off.

Figure 2, basic process of resourcing.

3.2.1 The change management of resources

The following is a compilation of interviews of former and current resource managers about the challenges of resource management and the system that is used.

The process is much more chaotic than what is presented in figure 1. There are multiple reasons for constant changes which require a substantial amount of change management from the resource manager. Some of the reasons for changes are but not limited to customers' requirements change, changes in supply chain, changes in project plans or designs, changes in other projects which cascade changes to resource pool, changes in global travel restrictions (such as pandemic measures) or some human factor (health issues, expired qualifications or whatever reason). This is presented in more detail in Stage 4, changes in resourcing and Figure 2, actual process of resourcing.

To combat these inevitable changes the resource management system and resource manager must provide constant correct information flow to all parties involved all the time. That is much easier said than done since the situation often is that nobody really knows what the impact of a change is, or the information is not given or otherwise unavailable.

What resource manager can do is to keep the resource management system Kyky-Set always updated very manually, provide information to all involved parties by emails and phone calls. This is very time-consuming and very frustrating for all parties.

This work is done by manually keeping up to date personnel data cards, project information cards, project resource plans, project requirements, site access data, some form of call to work emails with all the projects, checking qualifications and the list goes on. There are always at least five projects going on at any one time. There could be even fifteen projects of various types and scopes.

3.2.2   The human factor challenges with the resourcing process

There is also the human factor that the resource manager needs to deal with disappointments of all involved parties (workers, project management, customer, sales department) including his/her own. These disappointments are but not limited to: workers reject project, project reject workers, customer reject workers, Recion sales deem some worker a risk for a project.

Some of the reasons for a worker to reject a project: too long distance from home, family issues, challenging environment, health issues, personal quarrels with coworkers, vehicle problems, experiencing a lack of qualifications (true or false reasons).

The project may reject a worker because too long distance to work site, unfit for work environment, weak health for worksite (expect sick days to occur), unqualified for this challenging work (true or false reason) and quarrel with a coworker or a quarrelsome personality.

The Customer may reject a worker usually because of previous negative experience (usually a quality issue or a worker is seeming lazy) or some other preference. The sales department may also influence preliminary plans for resourcing a project if there is a known quality risk involved with a worker.

Mistakes in hauling, fitting or welding do not just cost a lot of money but the materials are hard to replace and are acquired from very slow supply chains (6 months or more of delivery time). These materials are mainly used only in power plants or pulp mills.

This seems to be an issue of bad personnel management and may be, but the real issue is a true lack of available qualified experienced workers. All workers must be qualified to for rare alloy high pressure piping. Losing a professional is a real loss for Recion and a win for a competitor. Therefore, issues with workers mentioned in the previous paragraphs must be tolerated to some extent.

3.2.3   Stage 1 of resourcing a project: preliminary plan, a rough estimate

In the interviews it was noted that each resource manager had their own methods for preliminary planning. The following is an average of three somewhat different methods.

When a project is sold to a customer there is some defined number of human resources that was considered. The problem is that the number is an estimate, and it really cannot consider how many people work at site at which week. Even if it would, just the changes in supply chain alone can change the number of people at site any given week. Although a professional project manager can do a quite accurate assessment of resources needed if a one involved in the sales process.

To make the best of it a resource manager makes a preliminary plan with a project lead and makes rough weekly estimates so the need for the weekly workforce requirement and is more accurate estimate. Based on this estimate a resource manager makes the reservation to the Kyky-set (the resource management system) project card. Some plans can be made with this information but there is a very high probability risk that dates and amounts of the workforce will change and the plans need to be changed or completely discarded.

With this rough estimate reservation of resource will provide some idea how much resources are tied to the project and the need for rental workers can be estimated. This estimate can be used to make preliminary queries about the availability of rental workers, but it is subject to change.

3.2.4 Stage 2: resourcing a project with the right qualifications and conducting resource planning

When the project mobilization date draws near, usually, one to six weeks before actual project mobilization the actual resource planning can be made. Although at this stage resource plans are also a very probable subject to change, there is usually a significant percentage of variables known and can be counted on.

3.2.5 Expiring qualifications

In this stage, the resource manager maps the potential workforce which has the right qualifications for the project. Almost all qualifications expire at some point, usually in three to five years, so with tens of people who each have at least three some sort of expiring qualifications. Kyky-set have this information available, but it is up to the resource manager to make sure that qualifications are not expired or expire in duration of the project. A welder may have eleven or more welding certificates, five safety related qualifications and five or more safety conduct passes for different facilities. All of those expire at some point.

To combat chaotic expiration of qualifications the resource manager may have the worker renew most of them during low season, so they also expire during low season. This means extra expenditure during a low turnover period but prevents a possible expiration problem during high season and may provide better control over the expirations.

3.2.6 Resource plans

The resource manager makes "final" plans for the start date and an estimate for end date for each site logistics personnel, pipe fitters and welders and foremen. This is done by linking personnel cards to project cards. Then if there is days or weeks of unemployment in between two projects for personnel, resource manager needs to order or better yet agree with personnel to have them use their accumulated vacation days, renew expiring qualifications, temporary lay-off or a combination of all three. The resource system Kyky-set is not able to help with suggestions or any other way but pure investigations (emails, phone calls, human memory) if some other project would have a suitable work for the person in question for the time between two original projects.

One factor is the overlapping plans with other projects. The resource manager can book the same person in Kyky-set for an infinite number of over-lapping projects and there is no alert in doing this. Kyky-set provides this information, but it must be checked manually. At this stage it is not a critical problem but will become a critical problem if the start or end date of the project changes and this is a thing that can be overlooked easily. Double booking also creates a false resource report that there are more workers than there actually are.

This stage is the latest when the resource plans are presented to project management and discussed about. Usually, project management wants some changes which in turn usually conflict with the whole company resourcing plans. This takes from the resource manager skill to communicate, negotiate, and compensate over significant obstacles. Those obstacles are but not limited to qualifications of resources, resources travel distances to project site and even personal chemistry between potential workers and project lead. The result of negotiations will be made as changes to Kyky-set.

Equipment, materials and even workforce are known at this point. At this stage the first changes in designs and the conditions in the work site will begin with their impact on the project implementation and one by one these changes will affect resource planning. Usually, these changes are unexpected challenges at completing a project stage with current workforce or changes in project scope. At this stage communication to the resource manager from project or work force begin to be crucial factor in success.

The only way to keep track of these changes (which keep rolling in in increasing intervals) is to keep the Kyky-set always updated and keep some sort of notes on why things have changed. Without notes of changes, it is easy to forget why something was changed and without explanation it will not make much sense later.

Then the resource manager needs to communicate the impact of these changes to the workforce, to other project managers which rely on the same workforce to be available in future for their projects and back to the project management team. Usually somebody is always left out of loop and the system doesn't provide any other assistance than being notes. When people are left out of the loop, there is always some sort of repercussion or expense. Least of those being annoyance but may also be an open conflict or something in between. Sometimes the changes help everybody involved, but that case is rarer.

3.2.7 Stage 3: call to work

At least two weeks before the project start date for a worker or foreman the resource manager calls personnel to work. The resource manager uses a call to work-document which serves as an information source for worker and a proof of procedure for resource manager. Ideally, the actual resourcing go as planned and every worker and foreman arrive at site on time.

At this point human factors start to impact resourcing. Health issues, wishes, demands, calls for a favor (usual but unconventional), car problems, family problems and the list of reasons go on. Resource managers need to compensate all changes that cannot be overcome by direction, calling favors, promises of various sorts or any other means.

Then all the parties involved need to be informed about the changes and their impact. Which is again an effort to take care so that everybody who needs to know is informed about the change.

Compensation may be calling another worker or a subcontractor to perform the work temporarily or for the project duration or depending on the need of the project maybe no compensation is needed. In some cases, compensation cannot be made, and it impacts the whole project.

3.2.8 Stage 4: Changes during the project

In every project there are some changes in human resources. Most common being but not limited to need for more workforce, need to cut workforce, need to delay incoming workers or need for replacements because of human factors, such as health, skill, vacations, need of other projects, personal issue or something along those lines.

Again, the resource manager needs to make new plans, keep the Kyky-set updated and inform every party involved about the impact of the change on all involved.
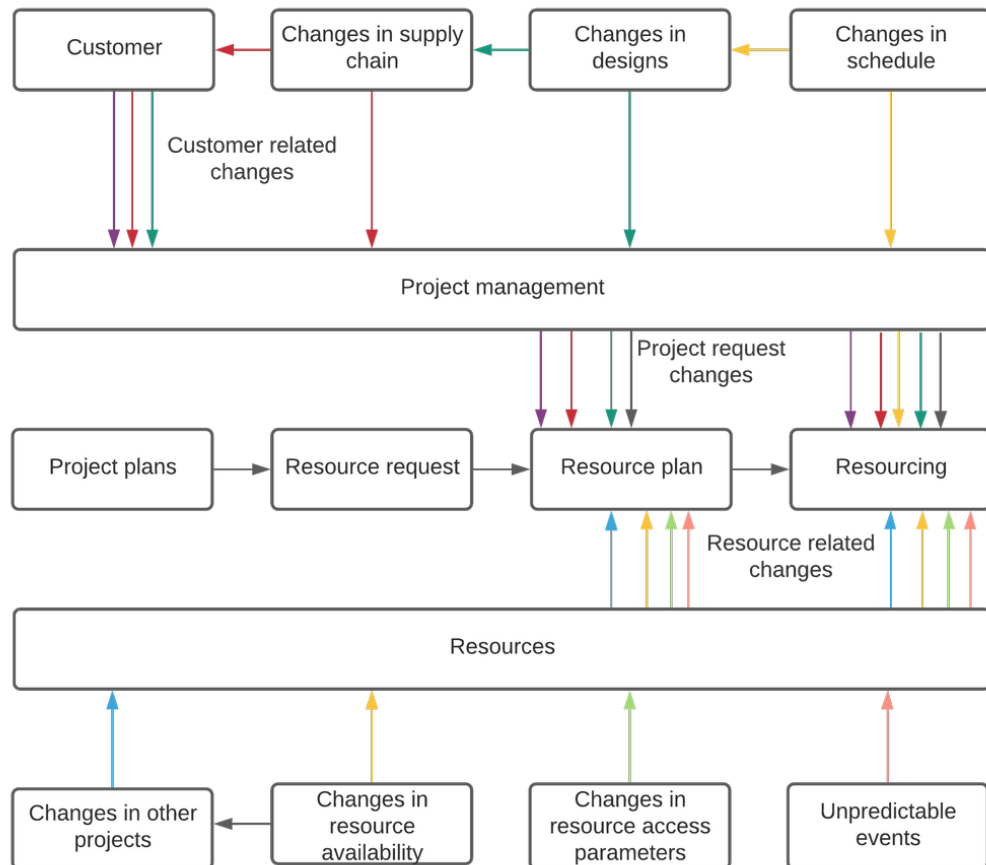
Figure 3. Actual resourcing

Installation resources need to be on one of the following statuses at any given time: Working, vacation, sick or laid-off. This causes a conflict of interest between project management and a resource manager. A project needs to be financially in budget and extra workers will not bring up efficiency. The resource manager needs to keep installation resources working all the time if possible. If resources are directed to unwanted vacations or lay-offs, they will go to competitor's payroll instantly or eventually. Sometimes a vacation or lay-off is welcome as the work is hard and days are long. Still, status: working is what everybody needs to be most of the time.

Due to niche expertise of Recion's installation resources they are hard to replace or to have a sort of buffer of resources by hiring rental workers or subcontractors. If using an excessive number of subcontractors, the changes may spin out of control because they are not directly in control of the company. Some parts of the project may be done with rental workers or subcontractors, which will help with overall company resourcing. But

that can also cause conflicts of interest since some projects or project stages are completed by subcontractors while there may be Recion workers laid off. In this case there would be a need to reduce the number of subcontractors' workers to make room for Recion's personnel but most of the time this does not make sense. If there is a week or two left for subcontractor's work, there is no point in bringing a Recion worker to that project just to finalize the last two weeks of work.

There is also a non-transparency issue in between Recion's selling process and resourcing process. Some of the time a resource manager is not aware of projects which may pop up on the resourcing schedule, but in recent times Recion's sales have become more transparent, and the issue of non-transparent sales process is declining. There still is no functional process in place to keep this in check and surprise projects still pop-up. This usually causes a wave of changes.

Loose contract terms for the Recion's customers and tight terms for Recion enable the customer to make sudden changes without significant additional costs. The reasons for customer-side changes cannot be eliminated by Recion but better contract terms would give the customer an incentive to try to prevent additional costs from the changes.

The human factors such as sickness and national and global events Covid-19 are out of Recion's control as well. With better recruitment and training programs in place there would be a possibility to gain more flexibility and resilience with installation resources.

The following table 4 represents the driver of change, reason, predictability, effect, and a possible method of preventing.

Driver of change	Reason	Predictability	Effect	A possible method of prevention
Customer	Varies	No	Changes in schedule, more or less resources needed than planned or a cancelled project	Better contract terms help but does not eliminate customer side changes. Some of the customer side changes happen because of

				some other con-tractor is lagging behind schedule and changes cascade through the project schedule.
Supply chain	Materials unavailable	Yes, usually the procurement unit can predict. Not counting on causes like Suez Canal block by ship Ever Given.	Materials una-vailable	Better supply chain design and active control of material flow.
Design	Flawed de-sign	Yes. Usually, a pro-fessional in pip-ing can detect flaws in designs beforehand.	Faulty materials or faulty prefab-rication.	Assign an expert to inspect pro-ject related de-signs as early as possible.
Schedule	Varies. Changes to the sched-ule can be caused by almost any-thing	Varies	More or less re-sources needed than planned.	There are usu-ally multiple reasons for one schedule change, hard to prevent or pre-dict. Many times there still are warning signs. Early and fre-quent communi-cation with the customer.
Other projects	Changes in resources in other projects.	Varies. Some of the ef-fects can be foreseen but not all of them.	More or less re-sources needed than planned or a delayed pro-ject. Unemployed re-sources or lack of resources.	Making plan B scenarios, fol-lowing schedule change signs on other projects.
Resource availability	Varies.	None. There are too many factors.	More or less re-sources needed than planned or a delayed pro-ject.	None.

			Unemployed re- sources or lack of resources.	
Access parameters	Change of work envi- ronment	Yes	Changes in ac- cess parame- ters, such as Covid-19 test or some other ad- ditional security measure	Early reaction and fulfilling se- curity require- ments
Unpredictable events	No	No	Resources una- vailable or un- employed	None

3.2.9   Stage 5 Changes in the project end

Usually, the project does not end on schedule. In a good situation they end earlier than planned but more usually they end a lot later than planned. These changes always im- pact workforce employment on other projects, vacations and lay-offs. Again, the resource manager must make new plans and communicate them to all involved.

The fluctuations with project end dates are so common that if the project ends as planned it may come as a surprise to the resource manager, but usually the resource plans are done according to this, so this case causes the least number of challenges.

3.2.10 Stage 6 Resource process after a project

After a project it is up to the resource manager to find the next project for the personnel. Many times, the timing cannot be matched with another project but there are some work- able solutions. First is to find some other project or a limited time at Recion manufacturing or "rent" worker for another company if possible. Second is to agree or order a worker to use accumulated vacation days, this must be done 2 weeks prior to the end of the project. Third is to lay-off a worker for a limited time, if the lay-off process is available. Fitting project schedules for personnel is a painstaking process, which would ease up, if re- sourcing system would have a feature to help with it.

3.3   Strengths of Kyky-set

The table below shows the strengths of Kyky-set with a brief description of the strength. A more detailed description can be found after the following table 5.

Strengths	Description
Near real-time information with local data-base	When working a local database response is fast and updates happen as defined by user in one minute or longer intervals. When with server database it's real-time but slow to re-spond.
Linked to vast amount of information	Linked with quality systems, qualification databases and welding logs and others.
Customizable	Possibility to customize everything, but no third-party support for it.
Cheap license	Relatively low cost of the software

The current state of resource management with aid of current system Kyky-set is a constant change management. Without Kyky-set the work would be a lot harder if not nearly impossible.

Most of the changes do not happen because of the actions resource manager but is in her/his responsibility to solve. The main time-consuming activity is coping and compensating with changes and informing all parties. To put it more simply the crucial element

with managing these changes is the management of plans, communication with all parties involved and keeping Kyky-set up to date with notes of the reasons for the changes. In addition, there is qualification management which increases the challenge.

The strength of Kyky-set is that it provides a near real time information of resources. In its heart is personnel cards which hold most of the information (contact information, addresses, ID-numbers, educations, photo and so on) about the company staff and their qualifications and that card is linked when person is assigned to project in Kyky-set.

Qualifications, especially welding certificates are currently tied through another program with Kyky-set resource management system. Welding certificates are also tied to welding logging and quality systems. This is worth mentioning even if this thesis does not comment more on the subject. But it is crucial aspect to consider if resource management system is replaced.

The clear strength of Kyky-Set is the vast amount of linked information which is structured well enough to make a real difference in planning company activities.

Kyky-set can also respond very fast when making change is local database function is enabled. The replication of databases (update with server) occurs in predetermined intervals every few minutes. Since the resource manager makes nearly all the changes, this is not an issue. On the other hand, the option of making changes directly to server database is terribly slow and cumbersome and that option is best for those who mostly read only the Kyky-set and do not actively make changes.

Notes platform is highly customizable and anything can be changed, if there is competent programmer available.

Finally the Lotus Notes platform is with low cost license.

3.4 Weaknesses of Kyky-set

The table below shows the weaknesses of Kyky-set with a brief description of the weakness. The more detail description can be found under the following table 5.

Weaknesses	Description
Lack of alerts or notifications	Qualifications expire and unlimited amount of user mistakes is allowed without any notification.
End of support	Lotus notes is not supported by IBM anymore. No third-party support and very few competent programmers available.
Reporting hard and faulty	Reporting basic resources demand vs available resources is hard and prone to mistakes. Graphs it generates need a lot of work to be useful.
No connection to payroll or HR systems	Kyky-set does not have a connection with personnel data with HR or payroll systems with basic information such as employment contract status, address, or phone number changes and such.
Integrity of the information content can be corrupted by human error	Human errors in using the system can cause cascading faulty information that takes very long time to fix. Allows double booking.

User interface is hard to use	User interface can be used only with training or with help of how-to notes.

The main weakness is the lack of automation in information flow and alerts of expiring qualifications and conflicts in planning. Also, reporting of resources demand forecast is quite weak.

Another weakness is that Kyky-set is irresponsive to accumulating changes which will affect all the company resources. The information is available, but it must be looked for and requires a lot of experience to control changes. These accumulating changes affect each other, and the system allows a user to make an unlimited number of mistakes. This may lead to the same worker booked on several projects for the same dates creating a faulty resource view. If one worker is booked for two projects for same dates, there appears to be more personnel than there really are, and it is usually found out too late.

Another critical weakness of the Kyky-set which operates on Lotus notes platform is that it is no longer supported by IBM. (https://www.ibm.com/docs/en/notes/10.0.0). Additionally there is no third party support available and there is very few Notes competent programmers available. Therefore, it must be replaced by a more contemporary system.

Also, the overview of the company resources and reporting that to company lead is unnecessarily complicated and prone to mistakes.

One weakness is that there is no connection between HR or payroll systems for basic information on status of employment contracts and address or phone number changes.

All of this change management takes a lot of time and effort just to keep resourcing plans updated. To my current knowledge there is possibilities in simple automation in contemporary systems which would help with accumulating and cascading changes and easier automated communication. Integrity of the information content may be corrupted by a user very easily and it is very hard to fix. Same person booked to multiple projects at the same time, project timeline can be corrupted with faulty information or resourcing needs can be deleted or an erroneous information input is allowed without any notifications. A

possible new resource management system must be able to help with the consistent information flow with better accuracy and less effort.

Lastly the user interface is hard to use by modern standards.

3.5   Identifying and prioritizing features needed in new system

This thesis identifies and prioritizes the features that are needed for the replacement system for Kyky-set. To keep this thesis from expanding too much most of the non-functional requirements are left out (even if they are mentioned or listed), such as browser integration, user interface and connections to other systems.

Most of the features Kyky-set has will be required in the new system also.

The core of current system Kyky-Set is the personnel card feature. It includes all the work-related information of the worker (with limited views to some users).

Personnel cards can then be assigned to a project card, so a project resource plan is a collection of these personnel cards. The personnel card also includes a list of projects that this card is assigned to.

Kyky-Set has a site resourcing feature which in turn is a collection of project cards which forms the list of all projects in the company or a unit.

Kyky-set also features a reporting system which generates an excel file with graphs for reporting. This feature has a great idea, but it is prone to mistakes and is arduous to correct.

Currently there are no notifications for a resource manager if someone else changes something in resource planning. This feature would be critical to avoid many mistakes in resourcing or communication. There should be an email notification or a change history available.

Kyky-set cannot be viewed with internet browsers. This feature should be in the new system.

There are no connections between payroll or HR systems to update personnel information on status of employment contracts or changes in addresses, phone numbers and such which are available at HR or payroll systems.

3.5.1   Summary of key features

The following list of key features for the new resource management system:

1. **Personnel cards**

    a. Access permits management and alarms of expiration

    b. Vacations, sick and lay-off reports and alarms of expiration

    c. Double/triple booking alert/notification

    d. Certificate management with expiration notifications

        i. Qualification cards with expiration dates

            1. Any card with number and expiration date

                a. Mainly safety and hot work cards

            2. Any qualification with expiration dates

                a. Lifting supervisor

                b. Welder's certificates

2. **Site resourcing feature**

    a. Lists with overviews of projects

    b. Overview of resources

c. Available personnel view

d. List of projects

e. Project timeline with forecast of open worker slots with a notes box

f. Project information card with

    i. "Työmaan pelisäännöt" -form

    ii. Site-access information

        1. Address and basic information

        2. Access parameters or site inductions or other requirements

    iii. Project resource forecast, weekly

        1. Project resource slots with qualifications requirements

            a. Option to limit slot filling with necessary qualifications

                i. Safety card (Työturvallisuuskortti)

                ii. Hot work card

                iii. Welders qualifications

                iv. Lifting supervision qualifications

g. Project info for workers email feature

    i. pesti-ilmoitus (call to work) + työmaan pelisäännöt

h. An hour sheet generation feature

   i. Generates an editable hour sheet from project and personnel information

i. A 'selling prospect' -feature

3. **Reporting tools**

   a. Company projects forecast with needed vs available resources with numbers

   b. Company projects forecast with needed vs available resources with graph

4. **An update notification feature which notifies when a chosen information is changed by someone else**

   a. Project information or slot changes

   b. Person status changes to sick, lay-off, vacation

5. **Can be used (or at least viewed) with internet browser or a smartphone**

6. **Connection with payroll or a HR system to update personnel information**

   a. Creating a new person card when a new employment contract is made

   b. Changing status of personnel which have terminated their employment contract

Most of the requirements needed for the new resource management system are the same already included in Kyky-set currently. The main focus is the new requirements which would make the new system significantly better than the current one.

Personnel cards

Personnel cards should include all the HR-related information on Recion's employees. These cards include basic information such as name, address date of birth, phone number, supervisor and so on.

The personnel card should also include linked data such as site access permits, vacations, sick days and lay-offs, all with an alarm of expirations. If any of these expire without the resource manager noticing it, it will have negative consequences. For example, if a site access permit expires and a worker is sent to that site, the worker needs to go through all the required inductions and the required qualifications must be presented. This usually costs at least a lost workday, possibly a work week or denied access until all the required qualifications and other paperwork is renewed. If a worker's vacation ends and no new call to work –order is sent to them, they need to be paid wages until another work is assigned to them.

Also, any qualification with an expiration date needs to have an alarm of expiration. These include such as hot work and safety card, lifting supervisor card and welder's certificates. One welder may have over ten different kinds of expiring welding qualifications which all are needed in projects at some point of time.

A personnel card should also trigger an alarm or a notification if the personnel card is booked to two projects with overlapping periods of time. Currently a person can be booked unlimited amounts of overlapping projects and that has proven to be an expensive fault to find every time. A person can be in only one place at a time.

Site resourcing

The site resourcing feature needs to include an overview of Recion's projects as a list with a timeline. Also, with one click the list of assigned resources should be viewed. Site resourcing view also needs to include a window with available resources during a selected time window and possibility to view all Recion's resources. In this view the available resources should be assigned to the projects and if a person is booked to another project on an overlapping date, it should trigger an alarm or a notification about double booking.

The project timeline should show the resource slots of the project. If a worker is assigned to the slot the name of the worker should show. Also, empty slots should be shown as well. These slots should be basis for the resources reporting and forecast of the required resources in the future. There could be an option to add a note to a resource slot, such as additional information about filling the slot with a qualified worker. From the site resourcing the project information cards can be accessed.

Project information card

A project information card should include all the basic information about the project. Estimated start and finish dates of installations, site address, project manager contact information, site manager contact information, site access parameters such as required qualifications and safety induction links or other procedures and requirements.

The project information card should also include "Työmaan pelisäännöt"-document which is intended for workers and has extensive information about the project.

Project information card should include the management of project's resource slots. Resource slots should have requirements which must be met in order to fill the slot. Must have requirements for workers are safety card and hot work card. Resource slots for welders should have welding qualifications requirements. Pipe fitters' slots could have a lifting supervisor or flange assembly training requirement. All the required qualifications have an expiration date and assigning a worker to a slot should run a check whether the qualification is in force for the duration of the project or not. If not, there should be a notification or a block for preventing an unqualified person to be assigned to the slot.

Project information card needs to have an email (or other type of message) feature that sends the project basic information and "työmaan pelisäännöt" -document to workers in resource slots. The message must include the start and estimated finish date of the slot (not project start or finish date). This could be the call to work feature that a resource manager could use to inform and send workers to project site.

Currently hour sheets for workers are done in spreadsheets and sent to payroll by email. The new resource management system's project information card could include the possibility to fill hour sheet that the payroll could access thus removing a need to send them by email.

Selling prospect feature

The sales department could benefit for a feature that they could establish a prospect project to resource management system. This would communicate the possible needs for resources in the future and so resource management and executive board could forecast the resource needs of the prospect projects.

Reporting tools

Reporting tools should be a real time status of resources currently used and forecast of the resources needed for sold and prospect projects. This should be presented in numbers and in a graph. Timeline of resources reports should span from a week to a year, scalable as needed. The report should show how many Recion's resources are available at any give time and the need for rental workers. This would aid executive board to understand the workload of the project installations and the sales so they could more easily see the available capability of executing a prospect project. This can also be used in companywide communications where the company staff is informed about current and incoming workload.

Update notifications

When a project information changes or resource slot opens, closes of changes there should be a notification for resource manager and the project management. This would improve communication which is usually obscured or forgotten to communicate. If a resource slot has a worker assigned to it and call to work message has been sent, the worker should be informed as well. If a worker status changes to on vacation, reported sick or laid-off, that should trigger a notification as well.

Internet browser support

Currently Notes platform runs on installed windows software and can only be used on the windows application. The new resource management system should at least be viewed if not used completely on an internet browser. This would improve the longevity of the software and make it more versatile in long run. Also using an internet browser as

a platform would give nearly significantly more options in every aspect than a installed software. Also a smartphone support should be considered.

Connection with HR and payrolls systems

Kyky-set used to have a capability to update personnel information by uploading a certain format of mass list of personnel information. However, this capability has been lost after several changes in HR and payroll systems. The new resource management system should be able to update personnel information with HR and payroll whenever it changes. If a new employee is hired or an employment contract ended this information should be updated too in the new system.

The next section discusses about finding the best practice on software requirement specification.

4 Finding the best practice on software requirement specification

This section discusses best practices on software requirement specification. It is a very important part of the software procurement process, so these practices aim to clarify the requirements for a new resource management system for Recion. For these purposes research from literature into best practices for specifying software requirements was conducted.

The literary sources include themes such as requirements analysis, requirement specification, requirement patterns and successful software procurement. In these sources are described how requirements are made with different methods and what steps are needed to form final requirements recommendations for Kyky-set replacement.

A new resource management system is needed because the current system Kyky-Set is obsolete and quite hard to maintain and lacks any automation or notification features. It requires its administrator to use programming language just to keep it up to date. It also does not have any logical automation that would help a resource manager to report statuses and planning, communicate more accurately on standard plans or avoid mistakes in planning. Accumulating changes increases amounts of possible mistakes that could be avoided by a simple notification of overlap. Notifications for expiration of qualifications would be a critical improvement on the current system.

The conceptual framework built for this thesis contains three methods for defining requirements:

- SAFe (Scaled Agile Framework) Lean Business Case -document,

- specification tree and

- user stories.

4.1 Principles for creating system requirements

According to Forselius (2013) an IT system development process consists of requirements specification, technical implementation, and requirements management. As

Forselius provides a complete guideline for a software procurement process, this work focuses on requirements specification only.

Development of any IT system is a complicated project which relies on the information that only customers can provide. The reason why many IT systems projects fail is the lack of the right kind of prerequisite work and definitions about the problems that the software should solve. For example, both customer and software company might have a lot of self-evident type of attitude towards a subject about a software which other party knows nothing about. That is why a process is needed to make sure that the customer and software company understand the subject in question in the same way.

Forselius (2013) states that the process starts with the idea of acquisition of a new system for a specific purpose is first presented in the buyer organization. In this case the idea could be described shortly: "Recion needs a new resource management system to better manage change and make less mistakes in resource planning and to better communicate and report plans and status of resources." Once the idea is described, it is important to consider and briefly describe who the users of the system are.

In an organization many improvement ideas may be floating around the company that gets no work effort at all. Some for good reason and some because of lack of resources or processes to process through them all. But when a critical improvement idea is found it needs to be defined the right way. Once the idea is defined it is followed by a lot of why related questions on behalf of software developers.

Pohjonen (2002) describes a document called requirement specification statement which is a collection of user requirements for a system to be developed. The Requirement specification statement defines the needs of the stakeholders with the new system concerned but does not comment on how technically this is achieved.

Specification statement is very important if an organization can produce it in with the help of software developers. This is just the starting point of the process and more things which require attention will appear as the process progresses. While stating specifications is a very important step, it is critical to remember that this is not an exclusive list.

One way to create requirement specification statement is to create Lean business case for an epic with SAFe. It is a form that is filled with the requirement specification information which in turn can be used as a starting point for a programming epic. SAFe epic is an agile method of a software 'project'. Though it is too wide a subject for this thesis, it's a method to consider when planning a large software project. More details in the Scaled Agile Framework (Scaled Agile, Inc. 2022).

Laplante (2014) defines Agile procedures as a family of unconventional software development techniques that have caught the attention of many people who are wary of conventional, methodical methods. Agile techniques are distinguished by their absence of strict processes; however, this does not imply that they are not rigorous or appropriate for industrial applications when properly applied.

Epics ≠	Projects
Implemented by stable, cross-functional Value Streams and ARTs.	Implemented by temporary teams, which disband after work is completed.
No definitive start and end date; scope is variable. Continue until WSJF says otherwise.	Definitive start and end date; scope is fixed. All scope must be implemented.
Progress is measured as outcomes against the benefit hypothesis.	Progress is measured based on task completion.
Lean Business Case, based on benefit hypothesis and definition of an MVP.	Overly detailed business case, based on speculative ROI.
Implementation follows the build – measure – learn SAFe Lean Startup Cycle.	Implementation typically follows phase-gated, sequential (waterfall) process.
After the Lean Business Case is approved, commitment is to the evaluation of the MVP.	After business case is approved, up-front commitment is made to the entire project scope.

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Figure 4 above illustrates the differences between Epic and Projects in software development (Scaled Agile Framework, 2022).

While agile methods are very strong method in hands of professional software developers, it could be very difficult for an industrial company to start an epic and arrive in reasonable time to a usable product. Once the basic requirements and functions are determined and documented, the agile method may be the best way of development a large software project in the long run. For example, a large software project could be something in scale of Finnish Health Care software Apotti.

Grady (2014) states that the specification tree is a major tool for preparing and maintaining program specifications. This is used to identify the architecture components for which

specifications will be required, and to determine the individual responsible for preparing specifications and requirements analysis.

The specification tree is a great way to present the final requirements, but this could be a very exclusive way to present requirements. The real danger is that something very essential may be left out. In Recion's case it cannot be a starting point of development.

4.1.1   Non-functional requirements

A requirement defines the activities a system must be able to perform, which is most important. Functional requirements are those that define what the system must do. The functional requirements are the focus of the definitions in this work although nonfunctional requirements play their own part too.

Nonfunctional requirements range from performance to operating systems to security standards. Withall (2007)

Pohjonen (2002) states that nonfunctional requirements define the conditions on which the system fills its functional requirements. Those being capacity, usability and response time.

Laplante (2014) claims that nonfunctional requirements (NFRs) are imposed by the operating environment. For example, those environments are quality properties, programming languages, timing constraints and such.

Sommerville (2005) describes nonfunctional requirements as a tree which has branches with three main categories: product requirements, organizational requirements and external requirements. The following figure illustrates the requirements as a tree.
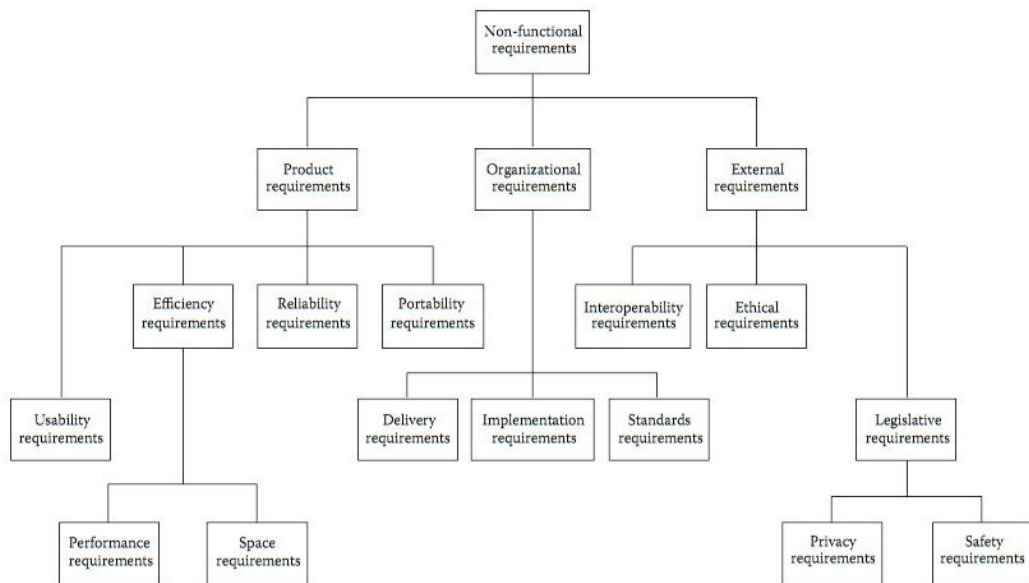
Figure 5. Tree of non-functional requirements (Sommerville 2004)

This work has only one non-functional requirement for Recion's new resource management system and that is that the system can be used on internet browser. The other non-functional requirements are outside of the scope of this thesis.

4.2   User stories

Forselius (2013) claims that the best way to generate functional requirements specification is through user stories. Users are divided into different user groups based on, for example, their method of using the system, frequency of use, user rights, or environment where the system is used. Neglecting a user group may lead to extensive and expensive patchwork later.

In contrast Withall (2007) argues that making user stories is an extreme process for generating requirements for an IT system with the result being the main functions of the system. User stories are assigned to developers, who then figure out how to implement them. The developers ask themselves what problems they are trying to solve and the write down the answers.

As Forselius sees user stories as the best method and Withall as an extreme process they both are right. User stories are the best method because the users themselves describe what they are doing and to what end. And with this method every user group can be considered with the real intention of paying attention to their needs in the new system. One benefit is that after a requirement is built the buyer organization can compare original user story to the requirement. This way a validation process of a requirement can be done very easily. The user stories are extreme method because it will take a huge amount of work by developers to analyze and record user stories as functional requirements.

Forselius (2013) describes the user stories as a best practice for creating requirements for a new system. This method has rules to make user stories most useful and interesting.

Rules are:

- The people have names

- The story is about how a named user does a work task with the aid of the system

- Not any mention about how the system does anything

- User only does successfully the tasks

- Stories are short

- Stories tell about a real business need of the system

- Every user group should a have a story for each of their use of the system

- Only one person per user group

If the rules are followed, then a user story is a very powerful tool for the buyer organization. There is very little risk that the software developer has a misunderstanding about a requirement. Also, the buyer organization can validate if the requirements do as the user story tell or not.

4.2.1 Terminology

Forselius (2013) states that gathering of terminology should be made by reading user stories. When there are several authors for user stories the problems with terminology become obvious, different units in same organization may have different names for same things. Terminology should be gathered in an alphabetical ordered list with synonyms and short descriptions and necessary translations.

The specification will be clearer and more useful if its terminology and organization of terminology are consistent. (Grady 2014)

Terminology can be understood in several ways so it must be defined what any term means in this case. The terminology can be formed by reading user stories.

4.3 Conceptual Framework of This Thesis

The research provided several methods to define requirements for a new resource management system. The conceptual framework built for this thesis considers three methods for defining requirements: SAFe Lean Business Case document, specification tree and user stories.

Requirement creation method	Strengths	Limitations	Implementation
SAFe Lean Business Case document	Enables developers to start an Epic development which aims for Minimum Viable Product (MVP): relatively fast development in large software projects	Minimum Viable Product may not meet the expectations and needs several similar cycles to produce a satisfactory software.	Implementation mainly in large software projects such as Finnish Health Care system Apotti.

Specification tree	Very visual and easy to comprehend the project and its parts and dependencies.	Very exclusive and therefore important requirements may be left out of scope which may be hard to implement later.	The known requirements are drawn as a process tree and dependencies are linked.
User stories	Easy to create requirements and to see if requirements are met or not	Requires substantial amount of analyzing from the software developer	Users write stories of successful use of system and developer analyzes and breaks them down to a workable plan. Rules of user stories must be followed.

The table 7 above summarizes the requirements creation methods considered in this work

Scaled Agile Framework is for professionals in software development for large software projects. As a such it would be a very big effort for Recion to use this method in developing just a new resource management system. That is the reason SAFe Lean Business Case -document is left out this conceptual framework.

Specification Tree is informative, but it is very easy to overlook some requirements, or they are presented in a wrong way, or the process might be faulty. In this thesis the requirements are presented in a Specification Tree but it is only for visual purposes, not for defining requirements.

The method for creating requirements for a Recion's new resource management system, the user stories method, is the most effective. User stories are chosen as the best way for creating requirements for Recion's new resource management system.

The user stories method has many advantages in Recion's case. First being that the actual stakeholders can create requirements through user stories without any experience in software development (although rules mentioned in 4.2 user stories must be followed).

Secondly by gathering user stories, it is possible to create and analyze processes in-volved in resourcing of a project. The third strength in this method is that it gathers the actual terminology used. The fourth advantage is that compared to specification tree, it does not limit the way the processes are mapped or exclude any information. And fifth strength is that software developers work can be validated so that will it meet the require-ments as described in the user stories or not.

A user story reveals many features, functions, and terminology which are otherwise hard to record, map and plan. That is why user stories are the best practice in this case. Also, user stories are quite easy for everyone involved to understand. In Appendix 1 there are several user stories to define how the new resource management system helps with resourcing.
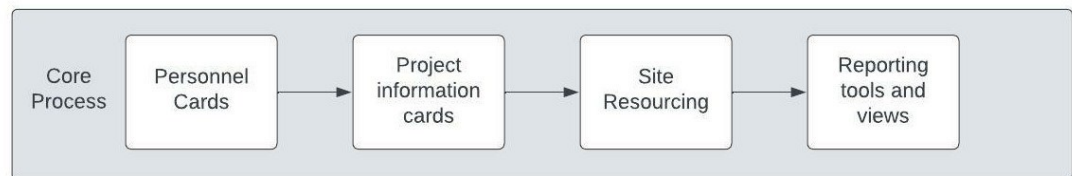

Figure 6 above illustrates the core process of site resourcing in resource management software. The figure is formed from user stories which in turn are written as defined by Forselius (2013).

Personnel Cards

In any HR work the work-related information about the worker is essential. In this case everything worker related information of a worker is found in personnel card or linked to it. It also must be limited in such a way that some of the user groups see only information they need to see and nothing else. For example, only HR or resource manager (if acting as a legal supervisor) can see the complete ID number, home address or contact info of a closest relative. Worker's qualifications are listed and linked to personnel cards. For example, the card information of a general safety qualification (työturvallisuuskortti) can be seen on personnel cards. This information is card number an expiration date. When a qualification is about to expire, there should be an alarm or a notification.

The information that a work site supervisor needs is, name, place of residence (not home address), links to professional qualifications, languages spoken by the worker and the work clothes size information (work site provide overalls and, in some cases, work shoes). Personnel cards can be linked to project information cards. So, project information cards become the resourcing plan of the project.

Project Information cards

Project information cards have information about the project. Location (address), duration (start and end date), required qualifications, safety induction information, work shift information, project scope in general terms. The project information card is a collection of personnel cards linked to the project information card. These personnel cards also have start and end date within the project duration. This way the project and resource managers record the start and end dates of a worker's posting on a project site. The tendency of overmanning a project should be limited to resource slots which in turn comes from project plans before starting the actual work. The slots should be limited but also extended as an emergency slot if an unpredictable event occurs, and more resources are required. Then there should be a record in the project reporting of the event.

Site Resourcing view

Site resourcing is a process what the main work of a resource manager. It includes lots of rules (such as collective agreements and internal guidelines) and regulations on how a worker can be posted on a work site. It is a complicated process which basically aims to keep projects resourced and employees employed while keeping track of annual overtime records and assigning vacations to workers.

Reporting tools

Reporting tools include a view of how much resources are needed in companywide projects and how many are available at any given time. This report is needed by the executive team, representative of workers, sales team, payroll and HR. Currently the reporting creates a messy excel file with a graph which needs to be cleaned or scrubbed because it usually contains faulty or wrong information. This report should always be correct and require no effort to produce and should be in real time. The next section is about building proposal on Resource management system for Recion.

5   Building Proposal on Resource management system for Recion

This section merges the results of the current state analysis and the conceptual framework towards the building of the proposal using Data 2.

5.1   Overview of the Proposal Building Stage

The Current state analysis showed that the current resource management system needs to be replaced. The reasons being the main weaknesses: lack of alerts and notifications, end of IBM support for Lotus Notes, very few competent programmers available, reporting is hard to do correctly, no connection between payroll or HR systems, user interface is hard to use and the possibility of losing integrity of the information content by human error. The integrity of the resource plans must be protected so that double booking a worker on an overlapping time period is not allowed.

To start procuring a new system the requirements for a new system must be made. For software requirements creation, the best practice was to create several user stories per user group to reveal the necessary functions and features. The user stories method was found during the researching the literature on software requirements and was mentioned in various sources several times. Also, the user stories method provides the maximum amount of information of requirements with minimum expertise on software development, which is crucial for Recion.

5.2   Findings of Data Collection 2

In conversations between two former resource managers and one current resource manager with addition to project managers and workers feedback the current state analysis was completed.

In analysis was found that the current system's weaknesses are lack of alerts and notifications, end of IBM support for Lotus Notes, very few Notes programmers available, reporting is hard to do correctly, no connection between payroll or HR systems, user interface is hard to use and the possibility of losing integrity of the information content by human error. For these reasons the system must be replaced.

The proposal building was conducted first by conversations between three people who have held the position of resource manager: director of pre-fabrication, a procurement engineer and the current resource manager. Second a video recording was made with online meeting to create a base for user stories for the new system. Third, the video and the user stories were analyzed to reveal core process and the required features for new system. The suggestions were made by current and former resource managers.

The table 8 below shows the weaknesses and suggestions from the stakeholders.

	Weaknesses of the current system	*Suggestions from stakeholders, categorized into groups (Data 2)*	*Description of the suggestion*
1	Lack of alerts and notifications	Notifications for expirations of qualifications and notification or prevention of double booking of resources	Many times, a workers safety card or a welding qualification expires during a project which takes at least a day of work to replace. Notification of expirations in advance would prevent accidental expiration of necessary qualifications.
2	No more IBM support for Lotus notes	A new platform for new system instead of fixing the current	Fixing the lotus notes platform only prolongs the inevitable problem that comes with an aging IT system so new platform is needed. The new resource management system should be usable in an internet browser.
3	Reporting is hard	Reporting of resources is real time with graphs	There should be a reporting window which gives an overview of resources status at any given moment with graphs and a timeline.
4	No connection to HR or payroll information	Updating personnel information between HR, payroll and resources should be automated	When a person changes phone number it requires the person to inform payroll which informs HR which in turn inform the resource manager. This should be automatic. Payroll also could benefit if hour sheets could be found in resource management system.
5	Bad user interface	The system should be easy to use	No one without a lot of experience can use the system properly.
6	Possibility of losing integrity of the	Error prevention alerts or blocking of error	There is a need for a block or at least notifications of double booking of a single worker on two or more projects at the same time period.

	information content by human error.		
7	It is possible to accidentally assign a person to a project who has no required qualifications in force	Resource slots for a project with qualification requirement	The resource slots are defined by project lead and cannot be filled with resources that do not have the necessary qualifications in force for the whole duration of project. This should also prevent overmanning a project since projects have just the planned slots. Although, projects could have an emergency slot which could be filled temporarily but would indicate a problem in project planning or execution and would remain seen in resourcing reporting.

The current resource manager suggested that the reporting feature and resource forecast should be a lot easier and more accurate. The connection between HR or a payroll system should be a feature since that data changes relatively frequently and it is hard to keep updated in several systems manually. Also, the call to work –feature would make the job easier and would replace manual emails and phone calls. To citate "In today's world it shouldn't be this hard just to make a report of resource plans. And why a single phone number change needs to be reported to three different units and still there might remain an old number somewhere".

The Procurement Engineer (worked previously as a resource manager) suggested that project information cards should include resource slots that could be filled only if the project requirements are met. The slots a project has would be based on project plans. There could be a feature such as an emergency slot, which could be filled in temporarily but would indicate a problem with project planning or execution. Also, qualification expiration notifications would make job a lot easier. The procurement engineer pointed out following: "There are always certain project managers which usually just happen to end up in emergency with resources. If reporting would show that an emergency slot has been in use for a period, it could be a driver for better planning performance."

The Director of pre-fabrication suggested that resource demand versus resources avail-ability reporting would be an asset when selling new projects at any given moment. To cite the Director "it's hard to sell when you really don't know if you can execute a project on that time period with Recion's resources or not. Also, it would be great if the sales unit could book preliminary resource slots for sales prospects."

5.3   First Element of Proposal

To procure a new system the requirements specifications must be thoroughly inspected and reviewed and reported to keep the project and expenses under control. For creating specifications in research was found that for Recion the best way is to create user stories of successful uses of the new system. In this way the features and requirements show up and the way the system is used is revealed with proper terminology.

Figure 7 below shows the draft proposal process.

5.4   Proposal Draft

The proposal draft is formed by analyzing the user stories in appendix 1 and to form them in a specifications tree for a visual aid only. The descriptions of the requirements need to be recorded by the software developer after complete user stories of all user groups are gathered. After the specifications are fully presented then the procurement should follow the best practice on software procurement.

While it was found out about the best practice for requirement specifications creation it was also found that the whole process of software procurement has been made and it's complete with forms and processes. All this can be found in a book by Pekka Forselius Onnistunut Tietojärjestelmän Hankinta, Talentum 2005. This book is recommended as a guideline from beginning of the procurement process until the end of it.

Figure 8 below shows the proposal for specifications for a new resource management system based on user stories and interviews with stakeholders. Please note that this is not an actual specification tree but an illustration of features supporting the core process.
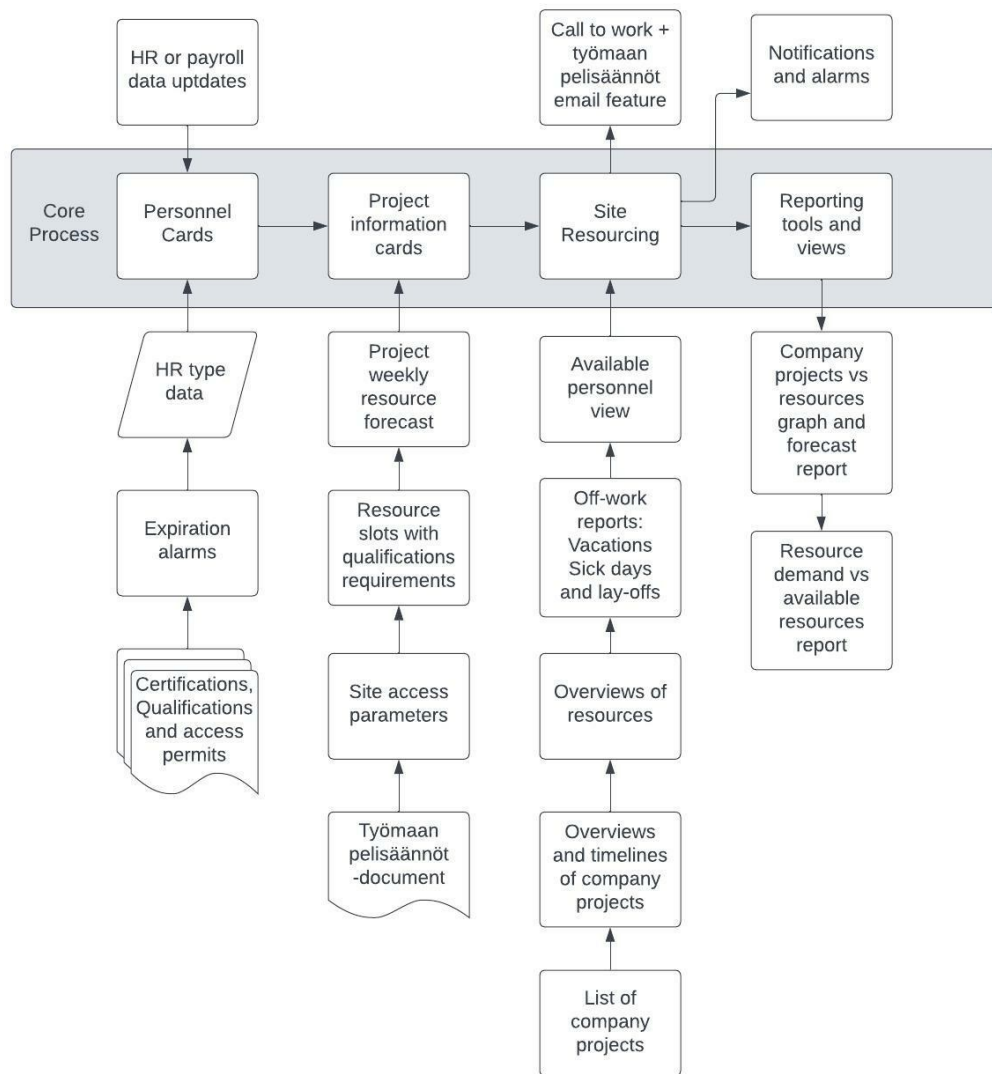
5.5 Proposal Draft in detail

During interviews with stakeholders, it was agreed that the current core process is good which can be used as a base for the new system's requirements.

5.5.1 Personnel cards

The personnel cards include all the work-related information about the employees. The is also currently restrictions on what different user groups can see about a person. Resource manager and HR can see all the information about a worker since it's crucial in everyday operations. Other users see only the necessary things, such as name, home city, qualifications and such. Other users have no access to vacation accumulation information, social ID number, home address, close relative information and such, since there is no need to and there is also GDPR rules to consider.

Figure 9 above Kyky-set's personnel card. For example, at the top there is "Kykykentät" information which can only be seen by Resource manager.

The HR functions and payroll systems should be able to update certain information on the resource management system. These include home address, phone number, accumulated vacation days. Also, resource management systems should be able to communicate these changes to HR too. One idea is that project personnel's hour sheets could be filled and read in resource management system, so payroll would have direct access to them. Currently they are sent in email attachments.

There is also a need for notification if a worker is reported sick, on vacation or has been laid-off for some duration. Usually, the site manager reports worker as sick so that information needs to be conveyed to resource manager and HR. Also, if site manager or resource manager has granted a worker a vacation, it should be known with all three stakeholders, resource manager, site manager and HR. During low season, winter usually there is possibility that some of the workers need to be laid-off for few weeks. In those cases, it should be known at least by all three stakeholders since laid-off workers need to be resourced at the first possible opportunity.

5.5.1.1   Personnel cards qualifications

An employee's work-related qualifications must be linked to the personnel card. These include but are not limited to: work safety cards, hot work cards, welding qualifications, site access permits, lifting supervisor licenses, EN 1591-4 Flange Assembly Competency and the list goes on. These all have different expirations dates, and an expired qualification usually restricts a worker from working on a site. Since there are 60 people or more with five or more expiring qualifications the is a lot of work to keep them updated.

Figure 10 above: There is a link to the welding qualifications (Hitsausosaaminen) as well as a link to other qualifications (Pätevyydet ja luvat) such as work safety card. There is also a link to safety gear allocated to workers (safety boots, welding mask and such). The figure is in Finnish as the Kyky-set software is completely in Finnish.

Therefore, there is a need for an expiration alarm for qualifications. For example, if a work safety card is going to expire in next four weeks, the system should have a notification and a reminder email about an expiring qualification. This should reduce qualification renewal days during a project which is always problematic. The notifications should be configurable in settings by a user. For example, a welding qualification is in

force three years so it might make sense to renew it during low time even three months before expiration date if a project is starting during this expiration period.

In the figure 11 above there is a list of one welder's welding qualifications. These happen to be expiring in February of 2024, but usually they all may be expiring in different years. Sometimes there is a hurry or some other reason only the qualifications that are needed on next project are renewed.

5.5.2 Project information cards and resource slots

The project information cards contain all the basic information about the project such as site address, accommodation address, start and estimated finish date, project number, project manager's and site manager's contact information and safety induction information and the list of work force as linked personnel cards. It also includes the resource slots and possible emergency slots with requirements and start and finish dates for each slot. These slots make the foundation of site resource forecast company wide.

The Project information card also includes the "Työmaan pelisäännöt document" which includes all the necessary information for everyone working at the site. "Työmaan pelisäännöt" describes in more detail such as site address, parking, accommodation address and other accommodation information, work shift information, start and estimated finish date, project number, project manager's and site manager's contact information, safety induction information, required basic qualifications, required welding qualifications, required lifting supervisor qualifications the list goes on.

5.5.2.1 Project information cards resource slots

The resource slots are a critical improvement. The resource slots have start and estimated finish date. These slots may only be filled with a worker who meets all the requirements that have been imposed on a slot. There might be an override function if it is known in advance a date when an expiring qualification can be renewed during a project without an impact on project progress. Minimum requirements are work safety card and hot work card and site safety induction training done (site access permits are granted after cards are checked before accessing site). A site storekeeper or a site officer may only require a work safety card and safety induction done. Welders should have all the required welding qualifications in force for the right materials for the duration of the project, which may be several.

Assigning a worker to a resource slot should prevent assigning the same worker to two different projects with overlapping time periods since a person can be just in one place at a time. There are some cases when a project can lend a worker to another project for a short period of time. These cases are rare, but it should be considered when resource slots are designed.

Emergency slots are for unpredictable needs of additional resources. Resource manager or site manager should be able to open an emergency slot to a project information card and this action must activate a notification. There might be an unpredictable expansion of scope on project, workers are sick or planned work stage is demanding more resources than initially planned. In these cases, the project manager, site manager and resource manager should have a notification of this action. Also, it should be shown in the resources forecast report. Then there is a basis for finding reasons and developing solutions to prevent this in the future.

5.5.3 Project information cards as basis for resource forecast

The filled and unfilled resource slots should be the basis for the company resource forecast which is critical for company operations. The forecast should show the required resources as well as graphs with indications of unfilled slots and emergency slots used currently and in the past. The resource forecast should be in real-time.

The resource forecast has its focus on the future, but the past should also be available for viewing. The realized resource reports should indicate the need for recruitment of new workers and how the projects have been able to forecast their resource needs. If a project has been using emergency slots it should be shown here. The use of emergency slots should be an indication of the need for improvement in project planning.

5.5.4 Site resourcing view

The site resourcing view is the most important tool for the resource manager. In this view the resource manager views all the project information cards as a list of company projects with start and end dates and the number of resource slots to be filled. This view also has access to personnel cards which in turn can be assigned to project information cards. In this view a resource manager sees the timeline of the company projects and plans and estimates the needs of resources.

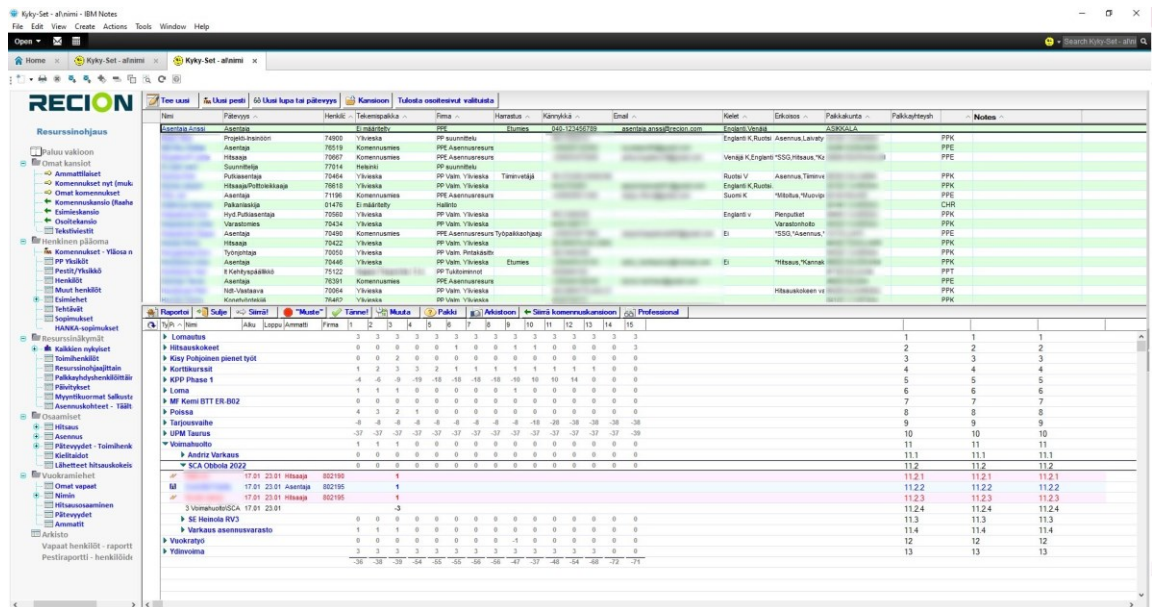Figure 12 above it is shows the Kyky set's site resourcing view. Above is a list of personnel and below is the list of project information cards with a timeline spanning 15 weeks. On the left column is a long list of different tools that resource manager can use. This view works very manually, but aspects of this should be considered when designing a new user interface for site resourcing view.

In this view the resource manager assigns workers to resource slots. When a resource slot has been filled it may require a project- or a site manager to approve the worker before plan is finalized (optional step). When resource planning is finished the resource manager can send a call to work message through email, SMS or maybe an app, to the workers. The call to work message includes a form which has all the necessary information about the project they are assigned to and the "työmaan pelisäännöt"-document or a link to it. After receiving the call to work message, the worker clicks a link to confirm that the message is received. Then an indication of this confirmation shows on the project resource slot and the resourcing of that slot is complete.

There must be a block or at least a notification to prevent a double booking for a worker overlapping time period. One person cannot be at two places at one time. If there is a need for an override function for double booking, then there should be left an indication that there is a double booking in place.

In site resourcing views there should be a resource list of available resources. There is a need for some indications if a worker is on vacation or on sick leave or has been laid-off. The Available resources list should include the start date when the resources are available and end date if it is known. For example, worker's current project end at week 43, friday 28.10.2022, so the view should show the name, profession and end date of the current project. On the other hand, if there is a gap between projects the available person's view should show current project end at week 43, Friday 28.10.2022 and the next scheduled project starts at week 45, Monday 7.11.2022. This should indicate the week gap between the project, and it would help resource manager to fill the time with a project, qualifications renewal if it makes sense or discuss with worker would it be time for two weeks vacations during week 44.

If a worker is unassigned to a resource slot, sick days, vacation or lay-off there is need for a notification at least four weeks in advance. This way there is two weeks' time for a resource manager to find a project or something else that a worker can be assigned to according to rules and regulations.

In site resourcing view there should be a notification if a resource slot has not been filled at least four weeks before the start of the slot's start time. If a resource slot has not been filled and the start date is overdue, this also should be shown in resources (forecast)

reports. This indicates the lack of available resources which may have a critical impact on the company projects and must be solved quickly.

5.5.5 Reporting tools and views with resource forecast

Reporting tools and views with resource forecast inform by numbers and graphs how many resources are needed in selected time span. Usual time spans are three months to six months. It simply tells what is demand of resources weekly and how many need to be rented or laid-off is the situation does not change.

Renting workers is good thing which tells that every Recion's worker has a project on that time period. It also means there is no capacity to sell. If there is more of Recion's resources than there are slots for workers, then there is capacity to sell. There is also an option to sell over resource capacity if Recion can use a subcontractor on some part of the project. Then this part of the project is in the hands of the project manager and procurement unit to find a suitable subcontractor with the right kind of resources. But using a subcontractor must be a planned choice and not a choice taken in an emergency.

5.6 Summary of proposal

For a new resource management system the core process and its supporting features is required. The requirements of the core process are Personnel cards, Project information cards, Site Resourcing and Reporting tools. The final requirements are extracted from user stories by the software developers. All user groups of the new resource management system must be gathered before software development. The best guideline for Recion's software procurement process is "Onnistunut tietojärjestelmän hankinta" by Forselius, 2013.

Personnel cards

Personnel cards should include all the HR related information, links to qualifications and access permits. Also, qualification and access permit expiration notifications or alarms should appear in personnel cards. The HR and payroll systems should be able to update Personnel Cards HR related information.

Project information cards

Project information cards should include the basic information of the project, such as site addresses, project and site management contact information, project number and so on. Project site access parameters or requirements should be available here. "Työmaan pelisäännöt" -document should also be located here. Most importantly, the project information cards should include resource slots with qualification requirements. These slots then in turn form site resourcing plan. Call to work message feature should also be in resource slot view. Project weekly forecast is formed by resource slot start and end dates. Projects should also be able to request an emergency slot if they unexpectedly need more resources.

Site resourcing

This is the main view of resource management. Recion's projects are displayed here as a list in a timeline. Also, available resources and unavailable resources (on vacation, sick days and lay-offs) are viewed here. Site resourcing view is also the best view to assign workers to resource slots. Site resourcing view could also have the call to work message feature. Notifications and alarms should be seen in this view. A block or at least notification should be triggered if a worker has been assigned to over lapping project.

Notifications for unassigned workers should be also appear on this view at least four weeks in advance before ending of a project, sick days, vacations, lay-offs or any assignment. Notifications for unfilled resource slots is also needed in site resourcing view.

Reporting tools

Reporting tools and views should show the company resources in projects and future demand for resources. Also, sales department's prospect projects resources demand should be included. The reporting should show the information in numbers and graphs.

In the next section, the proposal draft created in this section is validated in the next section.

6   Validation of the Proposal

This section reports on the results of the validation stage and points to further develop-
ments to the initial Proposal. At the end of this section, the final proposal and recom-
mendations and next steps are presented.

6.1   Overview of the Validation Stage

Currently Recion is using a resource management system which is on an obsolete plat-
form and is hard to use. It lacks features which notify users of qualification expirations
and allows double booking. One weakness is that it cannot be used in internet browser
and reporting of resources booked and forecast is difficult and prone to mistakes. There-
fore, Recion needs a new resource management system. The requirements for the new
system were presented to stakeholders as described in section 5.

The validity of the proposal for requirements for a new resource management system
was assessed by the stakeholders. First the proposal created in section 5 was presented
to the stakeholders and the logic behind the requirements were explained. Secondly
there were discussions about each of the requirements presented. The third step was
comments and concerns on the proposal. The fourth step was that stakeholders sug-
gested changes to the proposal and that remains the final proposal for requirements for
new resource management system.

6.2   Findings of Data Collection 3

Table 9 below describes the validation and comments of the stakeholders.

	Weaknesses of the current system	*Suggestions from stakeholders, cate-gorized into groups (Data 2)*	*Description of the validation*
1	Lack of alerts and notifica-tions	Notifications for expi-rations of qualifica-tions and notification	It is confirmed by stakeholders that noti-fications for expirations of qualifications and double booking are necessary. Ad-

		or prevention of dou-ble booking of re-sources	ditionally, it was suggested that and er-ror list of notifications should be availa-ble.
2	No more IBM support for Lo-tus notes	A new platform for new system instead of fixing the current	Stakeholders noted that Notes-platform is currently supported by HCL technolo-gies. This doesn't change the fact that the platform Kyky-set is built on is obso-lete and there is very few Notes pro-grammers available. It is agreed that the new resource management system should be usable in internet browsers.
3	Reporting is hard	Reporting of re-sources is real time with graphs	There should be a reporting window which gives a real-time overview of re-sources status at any given moment with graphs and timeline. This is validated as an essential requirement for sales team and company lead.
4	No connection to HR or payroll information	Updating personnel information between HR, payroll and re-sources should be automated	When a person changes phone number it requires the person to inform payroll which informs HR which might inform the resource manager. This should be automatic. The HR integration was vali-dated as good to have requirement but not as indispensable. Also the hour sheet option for payroll was validated as a good to have requirement.
5	Bad user inter-face	The system should be easy to use	Current users have grown accustomed to it. It is agreed that new users may ex-perience difficulties with Kyky-set user interface.

6	Possibility of losing integrity of the information content by human error.	Error prevention notifications or blocking of error	There is a need for a block or at least for notifications of double booking of a single worker on two or more projects at the same time period. It was acknowledged that during a resource manager vacations the substitute resource manager may easily book someone who is already booked. Therefore, a block or alert is necessary to prevent double bookings. These notifications should be added to an error list.
7	It is possible to accidentally assign a person to a project who has no required qualifications in force	Resource slots for a project with qualification requirement	The resource slots are defined by project lead and cannot be filled with resources that do not have the necessary qualifications in force for the whole duration of project. This should also prevent overmanning a project since projects have just the planned slots. Although projects could have an emergency slot which could be filled temporarily but would indicate a problem in project planning or execution and would remain seen in resourcing reporting. Stakeholders liked the idea of resource slots and emergency slots but there was a concern that it would turn the resourcing process too rigid or there would be an over-request of slots beforehand which would stay unfilled during the whole project.

6.3   Developments to the Proposal Based on Findings of Data Collection 3

The following describes the developments on the proposal on section 5.

6.3.1   Notifications of qualifications and qualifications

The proposal was that there is a need for notifications of qualification expiration and double booking. The stakeholders agreed that this is necessary. The qualification expiration cycles are hard to follow because there are so many expiring qualifications among workers.

However, there was some concern over notifications becoming too many. It was concluded that there is a need to specify later which kind of notifications they are. It was suggested that notifications should be added to an error list that is available for checking.

6.3.2   New platform for resource management system

It was agreed that the platform is obsolete. But the stakeholders pointed out that Notes-platform is supported by HCL Technologies company. It was also agreed that Notes programmers are very hard to find. Also, the non-functional requirement of browser support for resource management software was necessary.

6.3.3   Real-time reporting of resources and forecast

The main problem with current reporting is that it prints a faulty excel file that is hard to fix so that it shows the data correctly. And there is the fact that the status of resource forecast changes daily. It was agreed that reporting should be automated and in real time. Currently the sales team do not have recent enough reports of resource forecasts and reports used by the executive team tend to be at least a week old.

6.3.4   HR or payroll information integration

There is no integration between resource management system and HR and payroll systems. Resources management system requires personnel data to be updated and vacation accumulation information from payroll. There used to be a method to keep this information updated by uploading a specific type of excel file printed from HR and payroll but

after changes in payroll and HR the capability has been lost. Also, the hour sheet requirement would aid payroll.

The stakeholders thought that this is a good requirement to have but there have been other means to do all this manually.

6.3.5 Better user interface

The stakeholders noted that they are accustomed to the Kyky-set's user interface. It was also agreed that new user may experience difficulties in executing basic functions. A more modern user interface is required. The basic layout of the site resourcing view was good enough so that it may be used as a basis for the new system. Also, the personnel cards layout was seen as good enough. The project card and reporting view would need a completely new layout.

6.3.6 Notification or block to prevent double booking

One of the biggest flaws of the Kyky-set has been the ability to double book any worker. In fact, there is a possibility to fill one work site with using a single personnel card. Finding a person who is double-booked will make the resource manager doubtful of the correctness of the rest of the information as well.

It was validated that at least a notification and a symbol in resourcing view is necessary to indicate a double booking. Also, double bookings should be added to an error list for checking.

6.3.7 Resource slots

The idea of resource slots is a refinement of the weekly project resource forecast in project card. The resource slot is a limiting requirement to better reporting of project manning plans and project execution. Resource slots also should increase the predictability of resourcing, which currently is unpredictable beyond acceptable limits. This is because projects do not plan realistically enough their manning and there is always some sort of rapid change. These changes need to be reported to increase the predictability of resourcing.

The stakeholders agree with the findings on the current state analysis and the proposal. The concern is that projects may over request slots and there are open slots for the duration of the project, or some will use emergency slots constantly. The possibility of misuse of slots should show on the resource reporting and forecasting. There must be a tool to combat Recion's internal unpredictability of resources and resource slots is the best way to control the use of resources.

The qualification requirements for a resource slot are a must. Since there are different types of welders with different kinds of qualifications there must be a requirement for filling a slot. The qualifications must be in force during the duration of the project or at least notification is needed that a qualification will expire during the project. Projects work planning needs to be precise enough to predict the need of the any type of professional worker. There has been a tendency to hoard the best workers on a single project without a real need for their skills. For example, a welder with the most challenging qualifications is requested for a project but a regular pipe welder would do the same result for the project. Also, the more basic qualifications must be considered since a work safety card, or a hot work card renewal will lose a project one worker's workday.

The stakeholders had concerns that the resource slots might turn the resourcing process too rigid. On the other hand unnecessary hoardings of the best workers and the qualification expiration during the project is problematic. These issues must be automatically reported to the company lead and resource slots is seen as the best way to do it.

6.4   Final Proposal

The final proposal shows the changes requested for the proposal draft. The table below shows the original proposal and the changes in bold.

The changes are not very large but still essential. For example, changing the notification function into a color or symbol instead of an email is very important considering user experience. Flooding anyone's email by notifications will eventually lose the function it is supposed to do since in long run emails will be ignored. But a color or a symbol will be more effective with less distraction.

The following table 10 describes the final proposal and the comments of the stakeholders.

	Weaknesses of the current system	*Suggestions from stakeholders, categorized into groups (Data 2)*	*Description of the validation, change of proposal in bold.*
1	Lack of alerts and notifications	Notifications for expirations of qualifications and notification or prevention of double booking of resources	It is confirmed by stakeholders that notifications for expirations of qualifications and double booking are necessary. **A notification should be a color or a symbol indication of an incoming expiration instead of an email or a notification window. Also, notifications should be added to an error list.**
2	No more IBM support for Lotus notes	A new platform for new system instead of fixing the current	Stakeholders noted that Notes-platform is currently supported by HCL technologies. This doesn't change the fact that the platform Kyky-set is built on is obsolete. Also, there is very few Notes programmers available. It is agreed that the new resource management system should be usable in internet browsers. **An option using an HCL-supported platform should be compared to some new platform before making a platform choice. This choice must be considered with a very long time, at least 15 years, perspective in mind.**
3	Reporting is hard	Reporting of resources is real time with graphs	There should be a reporting window which gives a real-time overview of resources status at any given moment with graphs and timeline. This is validated as

			an essential requirement for sales team and company lead.
4	No connection to HR or payroll information	Updating personnel information between HR, payroll and resources should be automated	When a person changes phone number it requires the person to inform payroll which informs HR which might inform the resource manager. This should be automatic. The HR integration was validated as good to have requirement but not as indispensable. The option to have hour sheets in resource management system was thought to be a good requirement. **This integration is considered optional.**
5	Bad user interface	The system should be easy to use	Current users have grown accustomed to it. It is agreed that new users may experience difficulties with Kyky-set user interface. **The current user interface can be used as a starting point but needs a professional UI-designer to improve it.**
6	Possibility of losing integrity of the information content by human error.	Error prevention notifications or blocking of error	There is a need for a block or at least for notifications of double booking of a single worker on two or more projects at the same time period. It was acknowledged that during a resource manager vacations the substitute resource manager may easily book someone who is already booked. Therefore, a block or alert is necessary to prevent double bookings. **If a block is not created, then in addition to a notification there should be a color or symbol to indicate a double-booked worker. Error list**

			would provide more clear views of conflicts.
7	It is possible to accidentally assign a person to a project who has no required qualifications in force	Resource slots for a project with qualification requirement	The resource slots are defined by project lead and cannot be filled with resources that do not have the necessary qualifications in force for the whole duration of project. This should also prevent overmanning a project since projects have just the planned slots. Although projects could have an emergency slot which could be filled temporarily but would indicate a problem in project planning or execution and would remain seen in resourcing reporting. Stakeholders liked the idea of resource slots and emergency slots but there was a concern that it would turn the resourcing process too rigid or there would be an over-request of slots beforehand which would stay unfilled during the whole project. **It was agreed that all attempts at misuse of slots cannot be prevented, but rather there is still a need for case-by-case consideration by the resource manager.**

6.4.1 Notifications of expirations of qualifications and double booking

It was validated that there is a need for notifications of qualification expiration and double booking. The stakeholders agreed that this is necessary. The qualification expiration cycles are hard to follow because there are so many expiring qualifications among workers.

To prevent notifications flooding the users email, a color or a symbol should be used instead. Also, notification windows were considered but that feature reduces the quality of user experience since it is very annoying. In addition to color or symbol an error list should be available for checking.

6.4.2   New platform for resource management system

It was agreed that the platform is obsolete. But the stakeholders pointed out that Notes-platform is supported by HCL Technologies company. It was also agreed that Notes pro-grammers are very hard to find. Also, the non-functional requirement of browser support for resource management software was necessary.

An option using an HCL-supported platform should be compared to some new platform before making a platform choice. Using a Notes platform might provide significant cost savings.

This choice must be considered with a very long, at least 15 years, time perspective in mind. There might be a risk of needing to find another platform in upcoming years and then the funds saved by keeping the old platform will be lost. Anytime the platform goes obsolete, the system must be built again on a new platform. Using an internet browser-based platform would prolong the longevity of the new system.

6.4.3   Real-time reporting of resources and forecast

The main problem with current reporting is that it prints a faulty excel file that is hard to fix so that it shows the data correctly. And there is the fact that the status of resource forecast changes daily. It was agreed that reporting should be automated and in real time. Currently the sales team do not have recent enough reports of resource forecasts and reports used by the executive team tend to be at least a week old.

Reporting in real time is essential and that is why reporting requirement is a critical one.

6.4.4 HR or payroll information integration

There is no integration between resource management system and HR and payroll systems. Resources management system requires personnel data to be updated and vacation accumulation information from payroll. There used to be a method to keep this information updated by uploading a specific type of excel file printed from HR and payroll but after changes in payroll and HR software the capability has been lost. The hour sheets would be a good addition.

The stakeholders thought that this is a good requirement to have but there have been other means to do all this manually. Stakeholders commented that this update is run currently once per month. Since integration may be a difficult and costly process it was seen as an optional requirement which will be implemented if the cost is low. The hour sheets in resource management system could be a simple form that can be relatively easily integrated.

6.4.5 Better user interface

The stakeholders noted that they are accustomed to the Kyky-set's user interface. It was also agreed that new users may experience difficulties in executing basic functions. A more modern user interface is required. The basic layout of the site resourcing view was good enough so that it may be used as a basis for the new system. Also, the personnel cards layout was seen as good enough. The project card and reporting view would need a completely new layout.

There would be a need for a user interface designer project to improve the UI if the current one is used as a starting point.

6.4.6 Notification or block to prevent double booking

One of the biggest flaws of the Kyky-set has been the ability to double book any worker. In fact, there is a possibility to fill all work sites with using a single personnel card. Finding a person who is double-booked will make the resource manager doubtful of the correctness of the rest of the information as well.

It was validated that at least a notification and a symbol in resourcing view is necessary to indicate a double booking. Blocking double booking would be most effective but there are rare cases where intentional double booking is needed. But in any case, a double booking should be added to error list for checking.

There could be an option to remove double booking block but the color and/or symbol could not be removed until the double booking has been removed. Double booking is sometimes used intentionally, so a worker can be lent o another project e.g. for a week and then return to the original project. For the records there is a certain need to continue a worker posting in original project during a lend. It was concluded that it's easier to do intentional double booking in those rare cases than a new requirement for a lend-feature.

6.4.7   Resource slots

Resource slots are a form of requesting resources to complete a project. Currently the request can vary from specific requirements to list of names a project manager wants to a vague approximate requirement. A resource slot demands better planning since the number is limited and the essential requirements must be identified.

The resource slot in a project information card serves several purposes. It serves as a piece of information that makes up the resources report and forecast. It informs the organization of lack of needed resources and qualifications. It forces projects to plan better and limit or bring forward attempts to hoard the best professionals. And obviously it is the resource plan for the project and resource manager.

Resource slots may turn the resourcing process more rigid but it in turn reduces the seemingly unexpected resource requests. And at least if forces a project to explain why they need more resources.

It is acknowledged that projects may request too many slots or use emergency slots constantly. At the beginning it may be the case, but this also gives tools to indicate problems with projects and then the problems can be solved in the long run. Since unfilled slots ja emergency slots must show on resources report and forecast the issues may be addressed. Currently there is only a resource manager who knows how the resources are requested.

6.5   Summary of final proposal

The new resource management system should be on a platform with expected support time and versatility spanning a long-time perspective in mind. HCL technologies supported notes platform may be relatively inexpensive, but the developers are hard to find and the platform is very old. Choosing a Notes platform may have the result that this work needs to be done again in few years with new platform.

The user interface of Kyky-set can be used as a staring point with its strengths used in new systems user interface. But in anyway the interface should be made in modern standards with high usability in mind. This can only be achieved by a professional UI/UX developer.

For a new resource management system, the core process and it's supporting features is required. The requirements of the core process are Personnel cards, Project information cards, Site Resourcing and Reporting tools.

Every user group's user story of the new resource management system must be gathered for software development. The final requirements are extracted from user stories by the software developers. The best guideline for Recion's software procurement process is "Onnistunut tietojärjestelmän hankinta" by Forselius, 2013.

Personnel cards

Personnel cards should include all the HR related information, links to qualifications and access permits. Also, qualification and access permit expiration notifications should appear in an error list in personnel cards and in site resourcing. Also, if a personnel card is double booked this should appear on error list too.

An optional requirement for the HR and payroll systems: should be able to update Personnel Cards HR related information.

Project information cards

Project information cards should include the basic information of the project, such as site addresses, project and site management contact information, project number and so on.

Project site access parameters or requirements should be available here. "Työmaan pe-lisäännöt" document should also be located here. Most importantly, the project infor-mation cards should include resource slots with qualification requirements. If worker is double booked in two resource slots that have an over lapping time frame, a notification should appear on the error list.

These slots then in turn form the site resourcing plan. Call to work message feature should also be in resource slot view. The project weekly forecast is formed by resource slot start and end dates. Projects should also be able to request an emergency slot if they unexpectedly need more resources. If there is a reason to suspect that projects are misusing resource slots or emergency slots, there should be a process in place to take action of prevention.

Site resourcing

This is the main view of resource management. Recion's projects are displayed here as a list in a timeline. Also, available resources and unavailable resources (on vacation, sick days and lay-offs) are viewed here. The Site resourcing view is also the best view to assign workers to resource slots. The Site resourcing view could also have the call to work message feature. Notifications and alarms should be seen in this view. A block or at least notification should be triggered if a worker has been assigned to over lapping project.

Notifications for unassigned workers should also appear on this view at least four weeks in advance before ending of a project, sick days, vacations, lay-offs or any assignment. Notifications for unfilled resource slots is also needed in the site resourcing view.

Reporting tools

Reporting tools and views should show company resources in projects and future de-mand for resources. Also, the sales department's prospect projects resources demand should be included. The reporting should show the information in numbers and graphs.

With the final proposal now in place, the next section provides the conclusions for this thesis.

7   Conclusions

This section is about the conclusions of this work. It presents the executive summary and provides the next steps and recommendations toward implementation. This study finishes by a self-evaluation of the thesis and some final words.

7.1   Executive summary

The current resource management system Kyky-set is obsolete and needs to be replaced as soon as possible. That is why defining the requirements for a new system was the aim of this work.

Through interviews with stakeholders the current state of the resourcing process was analyzed, and it became clear that the new system should aid and make easier to manage the current resourcing process.

By researching literary sources and thus finding best practice to create requirements for the new system the user stories method was chosen for Recion. While other methods are good with professional software developers, the user stories keep the process simple and the aim clear for Recion. By telling the stories what the new system should accomplish there is very little room for miscommunication of Recion's needs.

The current proposal is formed from user stories and follows the core process of the resource management system. The uncovered requirements will improve the resourcing of project installations with better communication and better management of resources.

The requirements presented in this work were validated by stakeholders who have experience in Recion's resourcing, and they approve the suggested implementation.

When the decision for the new system is made, a stakeholder (a resource manager) who uses the system daily should be appointed to a project owner (a project manager of sorts). Then using the proposed guideline "Onnistunut tietojärjestelmän hankinta" by Forselius, 2013.", the project owner can oversee the development process from Recion's perspective.

Without proper software requirements, every software project will exceed their budget and project completion time.

7.2 Next Steps and Recommendations toward Implementation

When a decision is made to procure a new resource management system a project owned should be appointed. This project owner must be one of the stakeholders. The next step is to ensure that all the necessary user stories are written by the user groups. Then by following the recommended guideline the software and user interface design may start.

Using "Onnistunut tietojärjestelmän hankinta" by Pekka Forselius as a guideline there is a very good chance of good result. The book goes through every step in the process from beginning to end. Deviation from the recommended process without expertise will result in expanding project time and expenses and will affect the quality of the software.

7.2.1 Project owner and software requirements

The project owner should be one of the stakeholders or two stakeholders collaborating. The important part is that the project owner actively uses the current system and thoroughly understands the requirements.

The project owner or a support person, maybe someone from procurement, for the project should familiarize on the software project workflow as described in "Onnistunut tietojärjestelmän hankinta". Using this thesis as the basis for the requirements the project would have a solid starting point. Additional requirements could be discovered by writing more user stories. The user stories serve as a requirement catalog which must be decoded by software developers to functional requirements and non-functional requirements. One of the main responsibilities and restrictions of the project owner is to refrain from changing the completed requirements at all once the coding of the software project is started. If additional requirements and features are discovered, they should be added to a list of future features. This is very important to remember, and a way to avoid unnecessary expenses and expanding project competition time.

7.2.2 Software development and user interface design

The next step would be finding a suitable software development company to complete the project. A small software company with good references might be more versatile than

a large one with great references. A relatively small software company might allow better control and lower costs. If possible, it would be better to hire a Finnish company to reduce possible language challenges. One important aspect is that when the project is complete, Recion must have complete ownership of the software. Recion might have additional income through software licensing.

User interface will affect the user experience every time software is used. Therefore, it is a matter of great importance to have a good user interface. That is why there should be a professional user interface designer on the project. A good starting point would be to note the strengths of Kyky-set's user interface and weaknesses and then focus on improving on weaknesses.

A software project is like any other project. There is a need for milestones and time windows that force the project forward and keep it on budget. A software company and user interface designer must meet at least these milestones, but not limited to: project plan and schedule presentation, first demonstration of the product, UI demonstrations, first beta version followed by iterations such as personnel cards, resourcing view, project information cards, resource slots, notifications, reporting and call to work messages. Also, the support for the software must be ensured.

As in other projects there is a need for a project steering group which is made entirely of stakeholders. Their main function is to ensure that milestones are met in the window of time as agreed on the project plan. One of the main responsibilities and restrictions of the steering group is to refrain from changing the requirements at all. Changing the requirements in the middle of the project will increase exponentially the time and cost of the project. It is better to finish a project with functional software that might be missing a later discovered requirement than try to change the project scope. Usually features and requirements can be added with later versions at relatively low cost. Thus, the importance of collecting enough user stories before starting the project should be observed. They also serve as very understandable requirements.

7.2.3 Software 1.0

If all preparations are done well and the proposed guidelines are followed the result should be a functioning resource management system. Then the next steps are to bring up the list of future requirements and features and start the process again. The software

developer and user interface designer should remain the same but the preparation for version 1.1 should be done as thoroughly as before.

7.3 Thesis Evaluation

The objective of this thesis was to create requirements for a new resource management system. When comparing the initial objective and thesis outcome, the objectives were met. Critical requirements were identified, and a guideline was found.

The current state analysis was completed with interviews with every available stakeholder, former and current. The interviews could have been more comprehensive. Also, there were planned two workshops which were cancelled by pandemic situation, lay-offs, reorganization, and various uncertainty factors in Recion during 2021. Instead, there were several phone interviews, and one online interview to gather the minimum amount of necessary data.

The research process was to find literary sources on how to create software system requirements. There were lots of sources available on the subject with varying methods.

The research process was on the right track but could have been more thorough. The selection of sources in this work is not very comprehensive. With a wider range of the research would have had a stronger base of reasoning for this outcome, although the outcome would have been most likely the same. During research several ways to create software requirements were found but only one way that can be used reliably by a company which has no software development ability. The user stories method keeps control of the requirements in the client organization and it can be easily verified if the development goals have been met.

The list of final requirements could have been more comprehensive as well. For example, the qualification database has very little attention. In its core it is basically a list of qualifications which have expiration dates which trigger for notifications. The simple requirements were left out. On the other hand, if all the simple requirements were taken in to account the list on this work would have been in tens of requirements but with little additional value.

After all the challenges and personal hardships, which were several and very serious during this work, the objective of the thesis and expected outcome is what this work aimed for. The basis could have been stronger with wider research and better collaboration with stakeholders but if circumstances are considered, the work met its objectives.

The method, user stories can be applied to any software requirement creation with minimum expertise on software development. That makes the method quite universal.

For Recion this work serves as a solid starting point for a software procurement process and provides a clear guideline to follow.

7.4   Closing Words

Industrial Management Master's Thesis projects have a specific and concrete objective and outcome and an easy to follow gate model which supports the researcher from beginning to end in good order. This project produced a practical solution to the case company that should help Recion to replace the obsolete Resource management system. The clear, comprehensive and defined requirements for a software, established in this thesis, all contribute to Recion being able to carry out a successful software procurement project.

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Appendix 1 User Stories

Kati is a resource manager. Her task is to resource all the company's projects with qualified workers and is a supervisor for all the welders and fitters in the company. In her work she chooses personnel cards and links them to project information cards. Linked personnel cards in a project card makes the resourcing of a project. Resources reporting are formed from information contained in project information cards.

To resource a new project Kati must make a new project in resource management system. She clicks add new project and a project information window opens. Kati fills out all the essential information for the project, which includes the name and email of the project manager called Mika. Kati saves and closes the window. A project manager Mika receives an email that a new project is made for him. He follows a link which opens the project window and makes resources slots for the project and defines necessary qualifications. Kati can then assign human resources to that project which matches the defined qualifications.

Kati uses an 'available resources' -function and receives a list with available resources on the defined time slot. Kati selects a project and projects resources slots which she wants to make resource plans on. Following this Kati sees a shorter list of resources and then chooses the workers to fill the slots as allowed by the defined qualifications in the resource's slots of the project. After the plan is made Kati saves and closes the window.

Project manager Mika receives an email from Resource system that the resource slots of his project are filled. Mika then follows the link on the email and with a careful revision of the resource plan Mika either accepts or requests changes for some personnel using his knowledge on the project and personnel. Then Kati receives an email of the acceptance of her plans.

Kati has ready and accepted project resource plans with all the necessary information about the project. Kati can then press 'call to work' button which sends a generated email to workers with all the necessary information: estimated start and end dates, accommodation information, access procedure information and so on. The workers receive email and click accept the project, if the project is abroad, they can also reject the project. Now Kati has resourced a project.

Project manager Mika finds out that he needs two more people for his project in the near future. He opens the resource management system and selects his project. In the project

window Mika adds one resource slot for a welder with a required welder's certificate. He also opens another slot for a fitter to be the welders work pair. Since the work requires some lifting of heavy material Mika selects the fitter slot with a lift supervisor qualification. Mika saves and closes the window.

Kati receives an email from the resource system that a request for new resources have been made for Mika's project. Kati searches the available resources. She finds a welder with right qualification and fitter with a lifting supervisor qualification, and she adds them to the slot and saves.

Mika receives an email from the resource management system that his project's open resource slots have been filled. Mika accepts the plan right away. Since Kati has the resource management system open, she receives a notification and an email that the plan has been accepted and she can press the call to work button.

Jarno who is working as pipe welder in recion receives Call to Work email. In the email there is basic information about Mika's project (Start and end date, addresses to site, accommodation information, contact information and so on). The Call to Work also the required online training links for site access as well as required qualifications and welding cerficates. It also includes the "työmaan pelisäännöt-form" which has pay and bonus information, shift information and basically everything he might need to know about the work and work site. In the email there is also a link which goes to a web site where Jarno can confirm that he has received the Call to Work, and it has a field for possible questions. If the work was abroad the link would include the accept or reject the work option in reply. Jarno click confirm and Mika and Kati can see a notification that Jarno has received the Call to work and will be on work site as defined in the Call to Work.

Mika has information of an unpredicted development of a work stage in project. This comes up in a weekly meeting with a customer. Mika will need two more workers to site but has no resource slots left. Mika requests two emergency slots for his project resources which he gets. This action will remain seen in resources reporting and cannot be removed. This will be inspected and recorded as a lesson learned in future projects.

Arttu is a project sales manager, and he has a tender that needs his reply. He checks the start dates of the project in tender and compares them to resource management systems reporting timeline and notes that Recion has enough resources to undertake the project. Then he makes a prospect reservation of resources for the duration of the project.

CEO Jari is making a report for the company owners. To report company performance numbers, he needs to consult from resource management system of current state of projects. He notes that Mika's project is fully manned with two additional workers. He also notes that there is a prospect of a project which Arttu has made a preliminary reservation of resources. Jari also notes that Recion can still sell some projects in the next quarter.
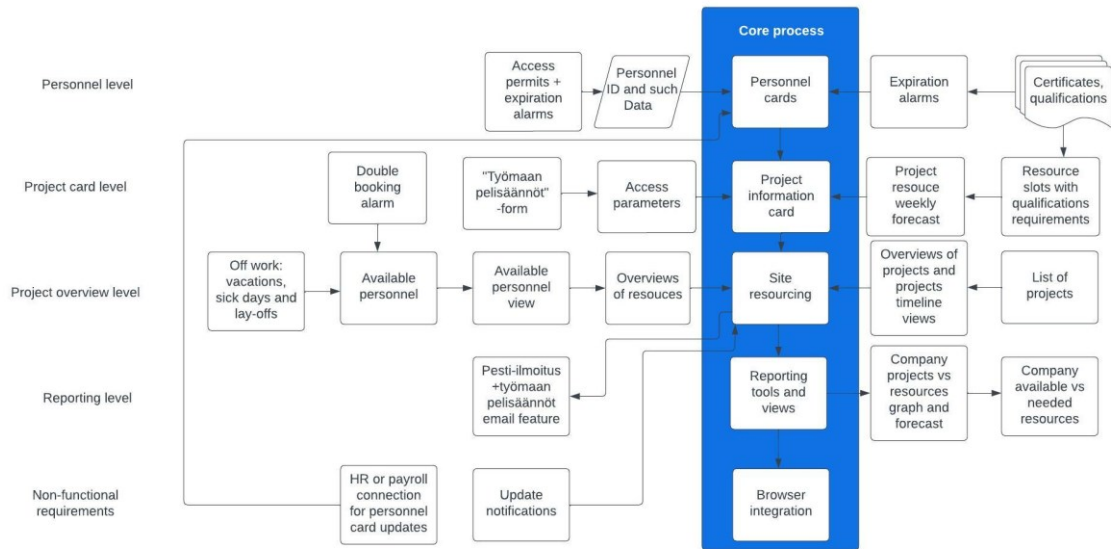
Kati receives an urgent request to send a specialized welder and fitter to a worksite. The welder and fitter needed are working on another project currently. Recion's Chief of operations order the resources to be lend from the current project for the urgent one. Kati opens an emergency slot makes a double booking. Since the urgent project will take 3 working days and the current project will be ongoing for three more months the impact for the lending project will not be severe. The double booking raises a notification window to confirm that it is intentional to do so. Kati accepts and those resources are double booked, and an error remain in error window until double booking is over. Also, a symbol is shown in all views next to their names that these two people are double booked. The emergency slot shows at resources reporting and cannot be removed.

Appendix 2 Terminology

Term	Definition
Resource slot	A predefined slot for a personnel card which has the right qualifications in force such as safety training card, hot work card, welding qualification, lift supervisor and so on.
Emergency resource slot	A temporary resource slot for a project with allows a project to request additional resources for a limited time. This action, however, will remain seen in project resource reports.
Resource plan	A list of names of the workers and start and end dates of the project for each worker.
Call to work	A procedure which orders a worker for a project with all the necessary information needed.
Access procedure	A combination of online and classroom trainings and qualifications for anyone who is going to work at project site.

Appendix 3 Specification Tree and Lean Business Case Form

Specification Tree

Lean Business Case Form

Funnel Entry Date:	Epic Owner:	Key Stakeholders:
(Use for tracking, aging and analysis in the Kanban)	(Who is the epic owner?)	(List the names of key stakeholders)

Epic Description:	
(Consider using the epic Hypothesis Statement in the epic article as a starting point for a description of the epic.)	

Business Outcome Hypothesis:	Leading Indicators:
(Describe how the success of the epic will be measured: for example, 50% increase in shoppers under 25; Availability increases from 95% to 99.7%, etc.)	(Establish innovation accounting metrics to provide leading indicators of the outcomes hypothesis: for example, a measurable change in purchaser demographics within 30 days of feature release)

In Scope:	Out of Scope:	Nonfunctional Requirements:
• … • … • …	• … • … • …	• … • … • …

Minimum Viable Product (MVP) Features	Additional Potential Features
• (Feature or Capability) • … • …	• (Feature or Capability) • … • …

Analysis Summary:	Go / No-Go:
(Brief summary of the analysis that has been formed to create the business case.	(Go, or No-Go recommendation)

Solution Analysis
Which Internal and/or external customers are affected, and how? (Describe the user community and any markets affected)
What is the potential impact on solutions, programs and services? (Identify solutions, programs, services, teams, departments, etc. that will may be impacted by this epic)
What is the potential impact on sales, distribution, deployment and support? (For external solutions or products, describe any potential impact on how the product is sold, distributed, or deployed)

Forecasted Costs	
MVP Cost: (What is the investment requested to fund the MVP (the MVP cost))?	**Estimated Implementation Cost:** (What is the estimated investment (cost) of full implementation of the epic if the MVP hypothesis is proven true? This estimate is refined of over time) Initial estimate: *This can be expressed as a range* Refined estimate(s): *Identify material updates to the estimated implementation cost, usually informed from experiments*
Forecasted Returns	
Type of Return: (Market share, increased revenue, improved productivity, new markets served, etc.)	

Development Strategy
In-house or Outsourced Development: (Provide recommendations for where the epic should be developed)
Incremental Implementation Strategy: (Epics are defined as a single whole, but each epic undergoes incremental implementation. Click here for details on potential strategies.)
Sequencing and Dependencies: (Describe any constraints for sequencing the epic and identify any potential dependencies with other epics or solutions)

Additional Supporting Data
Attachments: (Other supporting documentation, links to other data, feasibility or trade studies, models, market analysis, etc., that were used in the creation of the business case)
Other Notes and Comments: (Any additional miscellaneous Information relevant to LPM)