Quick guide for Industrial Management thesis works

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Abstract
Conducting a Master's thesis project requires a systematic approach and capability to conduct independent work. This guidebook aims to help on answering the questions which may popup on different stages of thesis.

The booklet has been developed from frequently asked questions document and been expanded to this size. The topics covered include: (1) starting a thesis work, (2) thesis proposal, (3) Structure of thesis, (4), Literature review, (5) Choosing a method, (6) Research methods in industrial management, and a set of (7) Practicalities.

This document is not intended to replace any book on specific research methods or layout guides provided by the university, but to give some hints and tips how to navigate through the process together with a company, your supervisor and yourself.

Keywords
thesis, guide, M.Sc.

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1 STARTING THESIS WORK

Thesis work is one of the final tasks of degree programmes in Industrial Management. The purpose is to show the capability of the student to apply theoretical knowledge and develop a conceptual or practical application. This short guideline has been written to answer some often-asked questions related to starting and completing a thesis work. The main focus of this book is M.Sc. level thesis projects, but in some extent the same principles apply to B.Sc. and doctoral levels as well.

M.Sc. thesis is planned to be completed in approximately 5 to 6 months of calendar time and 30 ECTS credits (M.Sc. in BA) and 30 ECTS credits (M.Sc. in Engineering) respectively. This gives an idea of workload of approximately 750 to 900 hours. This duration and workload combined with general objectives define what to expect from a thesis. Much smaller projects would probably not be challenging enough for a M.Sc. thesis and on the other side much longer and larger projects could be some other life objectives you would like to entail.

Q&A

Where can I get a topic for thesis?

As industrial management and information systems are quite applied areas many interesting problems take place in industry! For this reason, it is warmly recommended to contact some company in your network and ask for any thesis topic. Finnish companies are used hire students to complete this kind of 6-month assignments on special topics.

As a supervisor can you propose me a thesis topic?

Preferably no. And it is warmly suggested that problems for thesis are from industry. In some rare cases I can propose a theoretical study topic, but this should be a plan B. If you have your own topic in your mind, it is also fine.

How to get contact with a company?

Use your network or just make cold calls. Contacting sourcing manager or production manager is probably more efficient than HR department. It might be a good idea to contact

same companies where you have done your internships or your previous summer work. As M.Sc. student you are expected to have already some internship experience and now these links could be very valuable. Tools as LinkedIn might be a good way to.

Now I have a company and some idea what they want. What are the first steps?

- Please write a short one or two page thesis proposal and get approval from the company if you have understood the topic correctly. Contact potential supervisors directly or head of the programme to have a supervisor assigned. Supervisors will be assigned based on current availability and specialization fields. Unfortunately, you cannot choose your supervisor based on your own interests.

- Register and join Master's thesis seminars. Once you have an approved thesis plan you can register your presentation times. Two separate presentations are mandatory: thesis proposal and reporting results.

2 THESIS PROPOSAL

A good thesis proposal is a compact document describing the purpose, scope and objectives of your work. It is a document which describes what to expect in terms of possible results and deliverables and what are the key tasks and milestones achieving these. The nature of a thesis proposal is ambivalent: On the other side it is a contract type of document saying what you have promised to do and on the other side it is a small project plan describing what to do and when. It can be used in communication with your company to ensure that all parties understand the topic in the same way and somehow fix the plan from drastic changes during the execution phase. After approval of your plan, the main user will be you. It is a document that guides you what to do next and what are the remaining things.

For this reason, the thesis proposal should be a compact document with clear expressions. Everything should be described in a way that someone outsider could take the document and complete the work pretty much as you have planned.

2.1 Thesis proposal structure

The document itself should have no more than one or two pages and it should have the following sections:

2.1.1 Cover items

- Title of the thesis – This part should describe what you are aiming to do or what is the main focal area of your work. The title in the thesis proposal phase do not need to be the same as in final version of the actual thesis document.
- Contact names – To ensure communication between the parties related to the work, names, emails and phone numbers should be listed at least for (1) yourself, (2) company contact person, and (3) university supervisor.
- Date and version number of the document to ensure transparency and change history of the document during the planning phase.

2.1.2 Purpose

The purpose section should state clearly the purpose of the work and give some background information. In other words, you introduce the domain briefly, and present a research problem statement. Research problem statement is a sentence telling what you

are planning to do. It could be a problem you get from a company or some gap in the literature you aim to fill. Some of the items you could use to give compressed statement or question on your task are:

- Research gap – This is a statement where you express the current practices and what could be done alternatively. You also should say what you are going to do in order to study or fill this gap.

- Research problem – Research problem is a generic question, which is related to your planned work. You need not to be able to have the "final answer" on this question but advance understanding towards it. You should have only one research problem statement if you use this approach.

- Research question – Research questions can be used to outline some very practical questions, which you are supposed to be able to answer by end of your study. For this reason, the expressions used in research question should brief and clearly defined. No more that 1 to 3 research questions should be listed.

After presenting the purpose of your work, you should add a few words to justify its importance. Justification could be made because of (1) its impact size on people, companies, society; (2) citing some earlier works in the literature, or (3) general trends from the news or academic literature. You can even give an estimate of the number of people potential to impact or financial number of the foreseen impact.

2.1.3 Scope

The scope part is where you narrow down the scope, what you are going to do and what parts you exclude from the thesis document. Some examples could be related to your data, for example, you could say that you use the data collected from production department of a company within a period of time of 2018-2019 and taking the product families X, Y and Z into analysis. The purpose of the scope part is to keep the project in a reasonable size. This is also your insurance for the possible demands coming later once you already presented some interesting results.

2.1.4 Objectives

The objectives section is basically a tangible list of tasks or deliverables you are going to do in this project. In this section you should list 5 to 8 tasks that you are going to do during the thesis work and what you are going to deliver. The written thesis document is the part which is used for evaluating your academic mark, but it is a good idea to list also things

which you have promised to deliver to the company. Some example of practical objectives could include:

- *Literature review on recent papers studying the problem*
- *Data collected from ERP orders*
- *Statistical analysis of the order data*
- *Presentation to steering group on results*
- *Payback calculation*
- *Final presentation to steering group*

2.1.5 Schedule

Announcing schedule is important for follow-ups. The duration of the work should be around half a year. The schedule should say at least start date of the work, and planned finish date. You should use dates instead of just month level, which makes the planning look vague.

You can also list any other important milestones such as deliverables mentioned in the objectives. This can help you in execution of the plan.

Table 1. Example thesis schedule

ID	Description	Start	End
1	Literature review on latest works on big data analytics in supply chains	1.1.2021	31.1.2012
2	Getting familiar with company data and preliminary interviews	…	…
3	Thesis presentation in the university	..	..
4	Data collection from company ERP	.	.
5	Testing data analytics methods	.	.
6	Statistical analysis		
7	Presentation 1 for the company	.	.
8	Writing analysis		
9	Results reporting		
10	Final presentation for the company	.	.
11	Thesis presentation of results at the university		

2.1.6 Funding

In this section, you should mention how your work is funded. This is important especially if you have a company involved in the process. Are you working daily in a company and write your thesis evening time and weekends? Just shortly, what you have agreed with your company.

Q&A

Who should approve the thesis proposal?

Firstly, the contact person in the company and you should agree the overall thesis topic. This is the actual deliverables your company is expecting from you by end of the work. Once you have an overall idea you can contact your supervisor for review. From supervisors point the two main things are checked: (1) the scope of the work is within the expected limits of MSc. work – not too much, not too little, (2) the academic contribution is foreseen – e.g. use of methods and scientific approach on problem solving.

Can thesis be confidential due to company data?

Not completely. A public version of the thesis work needs to be available. A certain section can be taken out and stored as classified. The reason for this process is that evaluation should be transparent.

However, in practice, it is not recommended to separate classified parts unless that is really needed. The reason for this is that there are plenty of workarounds: You can give a separate deliverable to your funding company showing all the secrets in details, and for the public thesis report you can:

(1) anonymize your company name in the thesis without losing information.

(2) Instead of using real product or vendor names, you can use letters or numbers.

(3) You can censor graphs by showing percentages instead of EURs.

Eventually, some part of your thesis work will be a public document and will be available at Tritonia library at least.

Are printed hard copies required?

No, since August 2019, no hard copy submission is required. Instead, all submissions will be done digitally to the Osuva archive. Digital Master thesis works will be available in the university's open archive for anyone to read in the Internet. And whatever is in the Internet, stays there forever.

On exceptional cases, thesis work access can be limited to Tritonia library network computers only, but even in these cases thesis name, abstract and other metadata will be publicly available.

Yes/no checklist for thesis proposal

1. Do I have a clear idea of the topic?
2. Research questions are written down?
3. Unit of analysis is set
4. Potential data sources are identified and named?
5. Schedule is defined
6. Is topic approved?

3 STRUCTURE OF A THESIS

It is a good idea to start outlining a skeleton of the thesis document early. This helps you to think where to put things. A standardized form of an academic paper of thesis is very often close to five main section structure and this is what is a warmly recommended approach from both writing and reader points of view. Once everything is on the places where they are as expected conducting the work is smooth.

1. Introduction
2. Literature review
3. Method
4. Results
5. Conclusions

Structure of the thesis work in five main section covers the following items:

(1) Introduction part is very much repetition of your thesis proposal and this is where you have the problem statements, research questions and justification, backgrounds and so one.

(2) Literature review section should tell about the earlier works related to your research problem. You can choose up to three (no more) related theoretical frameworks, which are directly related to your work. The literature part should not be a loose section, but it should be tightly linked what you are actually trying to solve.

(3) Method section should be very compact, preferably only 1 to 3 pages. This is the cookbook section of your work. By reading this, another academic reader should be able to repeat your study and replicate the results. So you need to be very precise on this part – explain your unit of analysis, data, process steps, tools used and methods in detail. This section should not be a lecture of philosophy of science.

(4) Results part is the main part of the document. This is your main contribution as it should show how you have been able to utilize your skills to apply scientific knowledge in a real environment. This section can include figures, tables, photos and wide descriptions what the results are.

(5) Conclusions section generalizes the results beyond the current study and its data. In this section you should think what the results could mean for other similar organizations and what are the limits of the applicability of the results.

Overall thesis document should have around 80 to 100 pages and the main emphasis should be on results section, approximately 30-40% of the total content.

4 LITERATURE REVIEW

The purpose of the literature review is to present the recent works which are related to your research problem. Do not aim to give a generic lecture on generic topics such as quality management, lean manufacturing or supply chains – the reader may study these matters from other textbooks. Instead of this, present what are the latest advancements and approaches to solve similar problems and what we can learn from the past works.

For the literature review, you should cite academic works, which means textbooks and academic journal papers as well as conference papers. Professional magazines may also present a good overview on practical implications.

Finding academic articles

There are several publishers of academic journals and each of them have an own search system to find the articles by using keywords or author names. For a practitioner, a quick way is to use Google Scholar search by standard search terms. e.g.

- +"logistics" "information systems"
- "big data analytics" "industry"
- "competitive strategy" "production"
- "vendor selection"

By using university computers, the links should work directly to Tritonia library sources. Other computers outside the university network may have difficulties to find the direct access to papers but once you have found the paper, most likely there is a source available by using proxy.tritonia.fi. Then you just need to know the publisher of the journal and find the paper via that link.

How to make a literature review as a part of thesis?

Every research should have theoretical background, which means that a researcher have to do some kind of literature review before making a questionnaire or a list of questions for an interview as well as before gathering data of any kind.

A systematic literature review (SLR) is an explicit and methodical way to gain deep knowledge about a given topic to inform researchers and practitioners. An SLR follows a strict set of guidelines and adopts a replicable, scientific and transparent process. It improves the clarity of scholarly communication, increases internal validity (against selection and publication bias) and creates transparency through the auditable process. It

can be made for example by following the five-step guidelines on conducting systematic reviews:

- Step 1: Question Formulation: Establish focus and make a clear research question.
- Step 2: Locating Studies: Methods used to find studies (databases and other searches)
- Step 3: Study Selection and Evaluation: Inclusion and exclusion of articles. Exclude those themes and issues from the literature search, which are not included in the research question(s). Make the search based on peer-reviewed English-language peer-reviewed journal articles since the selected year (like the years 2011-2017) as well as use high-quality databases, like EBSCO database.
- Step 4: Analysis and Synthesis: Breakdown individual studies into parts and identify associations between parts
- Step 5: Reporting and Using the Results: Summary of all studies from data extracted – what is known and not known about the question (Ali et al. 2017; Maylor & Tuner 2017)

Academic journals

The number of academic journals has been mushrooming exponentially during the past years. Here's a list of established journals with a good reputation:

- Journal of Operations Management - http://www.journals.elsevier.com/journal-of-operations-management/
- International Journal of Production Research http://www.tandfonline.com/toc/tprs20/current
- International Journal of Production Operations Management - http://www.emeraldinsight.com/products/journals/journals.htm?id=ijopm
- Production Planning and Control - http://www.tandfonline.com/toc/tppc20/current
- International Journal of Production Economics - https://www.journals.elsevier.com/international-journal-of-production-economics

- Supply Chain Management: An International Journal - https://www.emeraldinsight.com/journal/scm
- International Journal of Logistics Management and Physical Distribution - https://www.emeraldinsight.com/journal/ijpdlm
- International of Journal of Logistics Research & Applications - https://www.tandfonline.com/toc/cjol20/current
- International Journal of Business Logistics - https://onlinelibrary.wiley.com/journal/21581592
- International Journal of Quality and Reliability Management - https://www.emeraldinsight.com/journal/ijqrm
- Management Science - https://pubsonline.informs.org/journal/mnsc
- Omega - The International Journal of Management Science - https://www.journals.elsevier.com/omega
- Journal of Product Innovation Management - https://onlinelibrary.wiley.com/journal/15405885
- Industrial Marketing and Management - https://www.journals.elsevier.com/industrial-marketing-management
- Industrial Management and Data Systems - https://www.emeraldinsight.com/loi/imds
- Computers in Industry - https://www.journals.elsevier.com/computers-in-industry
- International Journal of Computer Integrated Manufacturing - https://www.tandfonline.com/toc/tcim20/current
- Journal of Cleaner Production - https://www.journals.elsevier.com/journal-of-cleaner-production

Associations and Magazines

- APICS Magazine - http://www.apics.org/industry-content-research/publications/apics-magazine
- Harvard Business Review - https://hbr.org/

- MIT Technology Review - https://www.technologyreview.com/
- California management review - https://cmr.berkeley.edu/

Conferences

- XPlore - IEEE conference proceedings - https://ieeexplore.ieee.org/Xplore/home.jsp

5 CHOOSING A METHOD

Research problem determines or at least delimits the range of the methods that you can use. There are two main types of research problems:

(1) Nomothetical – asking how things are currently?

   a. *What is the estimated market size for smart grid products?*

   b. *How operator behaviour affects on product quality?*

   c. *What is the current weather in Vaasa?*

(2) Normative – asking how things should be in the future?

   a. What is optimal reorder policy for spare part items?

   b. How modularity should be taken into account on product design?

   c. What should be the temperature in a nice midsummer day in Vaasa for enjoying?

Use of data is another dimension to map your research approach. Sometimes access to certain data defines the methodological approach. A good set of data can provoke interesting questions, which may be tested and developed further. Purely conceptual work may take place in some rare occasions, but some kind of empiria is expected to be included in the thesis works. In cases of developing decision support models, e.g. something like using EOQ to define optimal lot sizes, assumptions may be used without actual recorded empirical data. Same applies to computer simulation in some extent as well.

Table 2. Research method quadrant

	Theoretical	**Empirical**
Nomothetical	Conceptual - Ontology development	Descriptive - Survey - Exploratory case study
Normative	Decision support - Decision support - Simulation	Design study - Six-sigma, lean - Process improvement - IS design

Unit of analysis is one of the methodological elements you should define very early. This could be for example *individuals working in an organization, customer companies, a certain factory, a group of products marketed in Asia, Latin-American countries*.

Case study and design science is a common approach used in industrial management thesis works as the companies are often initiating the research task and paying for the execution. Generally, case study research method is common in social sciences and it often provides a close and deep view on exploring the subject of the study in certain environment. Case studies can be conducted by using a systematic and formal approach. Action research is a specific type of case study where researcher is involved with the subject to be studied. This may give a biased view on the subject, but it can also provide an in-depth view on the details.

Case studies may be exploratory aiming to build understanding how things are. Another approach is design science, which is originating from information system design. Here the researcher is involved with the case organization and aims to build a technical solution to solve the presented problem. Design science studies concentrates on development of systems and their performances. Examples of developed solutions in design science approach could include: algorithms, information systems, new process models, engineering management approaches, business models or service operations.

Both case study approaches, exploratory and design sciences are very pragmatic. Exploratory studies contribute on general understanding of the phenomenon. Design science approach (sometimes called also as constructive research method) provides immediate value added to the company by proposing a technical solution.

6 RESEARCH METHODS IN INDUSTRIAL MANAGEMENT

This section introduces some possible and often used research methods in the industrial management. The purpose of this section is to show some possible ideas with exemplary thesis works and further reading for the approach. This list is not exhaustive or complete by no means, but the aim is to introduce some typical approaches with reasonably fresh thesis works which you may find from the library.

Yes/no checklist for thesis research method

1. Is my method suitable for answering the research questions?
2. Do I have an access to data needed?
3. Do I know what to do exactly once data has been collected?

6.1 Decision support methods

Method

Decision support systems are normative tools, which aim to help managers and other decision makers to have a suitable or optimal solution for a problem. Decision support systems are often quantitative tools, which use assumptions and data collected from existing environments. This category could include a whole range of tools to give an analytical and replicable guidance for a decision-maker.

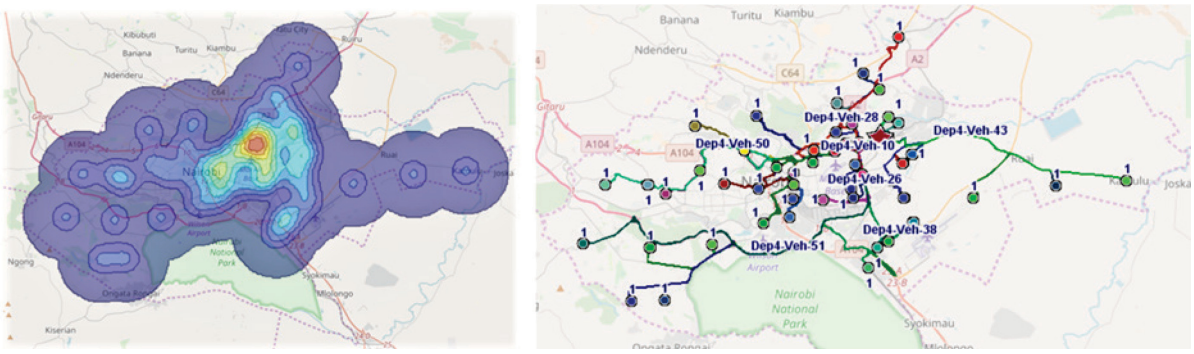


Figure 1. Vehicle route problem solution and heatmap

Questions

- What is the reorder policy we should use for replenishment stock?
- What is the estimated ROI for a windfarm investment?

- How many trucks are needed to serve a daily delivery programme?

Tools

- Inventory models: EOQ, EOI, EOP
- Forecasting models - EWMA
- SPC models for quality management
- Vehicle Route Planning

Data

- Real factory data collected from ERP systems
- Assumptions collected from machine providers, production experts
- External secondary data

Further reading

- Williams, A. S. (2000). An Introduction to Management Science, Quantitative Approaches to Decision Making. South-Western College Publishing.
- Powell, S. G., & Baker, K. R. (2009). Management science: The art of modelling with spreadsheets. Wiley.

Example of a thesis using this approach

Thesis reference	Varjonen, Essi (2018). Route optimization of waste collection vehicles to the decentralized waste-to-energy power plants.
Problem	Analysing power plant logistics and waste collection and showing the key performance indicators for centralized and distributed scenarios.
Unit of analysis	Trucks
Tool	Open Door Logistics software for VRP solving
Data	Census data, GIS data from Kenya, cost data based on experts
Outcome	A payback estimate for distributed collection of waste

6.2 Using statistical data

Method

Statistical tools are often related to data collected from a case company relating to various sources and aiming to provide a systematic analysis of the current situation for the process improvements. This approach is used often in quality related improvements (TQM, lean six sigma), operating performance (OEE) or inventory control (ABC analysis). Very often the main purpose is to find the 20% of the sources affecting the 80% of the results (Pareto approach).

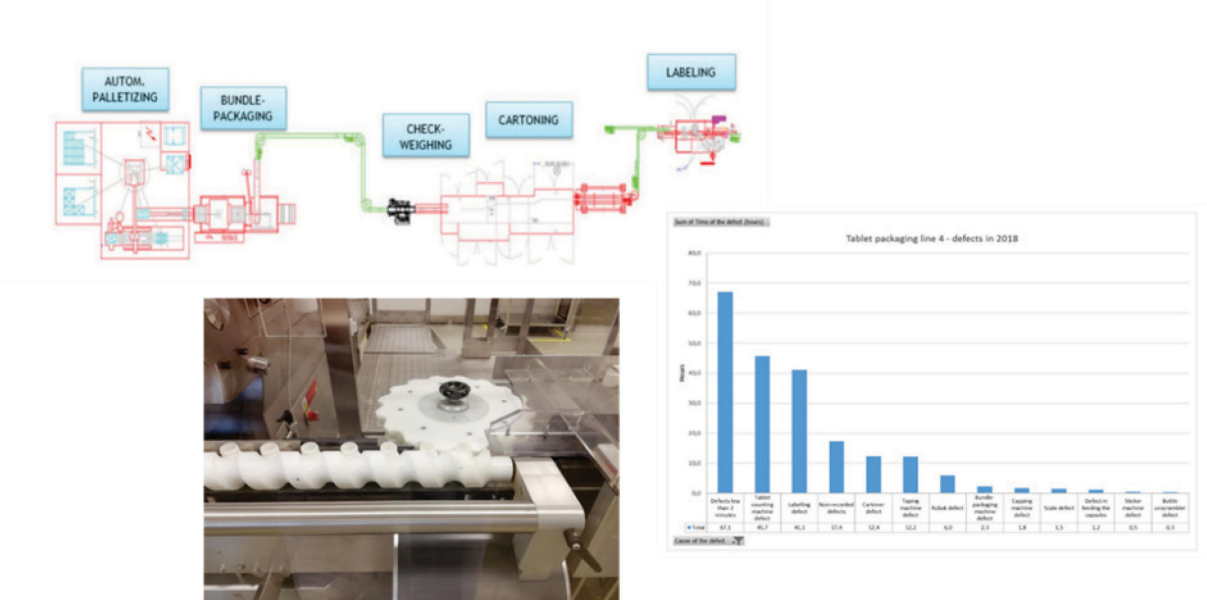


Figure 2. SPC analysis of a production line

Questions

- How to improve first pass yield quality of a production line?
- Which stock keeping items should be moved to vendor managed inventory?
- Which products are most profitable for the company?

Tools

- Pareto/ABC-XYZ analysis
- Lean sig sigma tools – fitting distributions

- ANOVA

Data

- Real factory level data
- ERP data
- Interviews with decision makers and key stakeholders
- Secondary data from public sources

Further reading

- Brook, Q. (2010). *Lean Six Sigma & Minitab: The Complete Toolbox Guide for All Lean Six Sigma Practitioners*. Winchester, UK: OPEX Resources Limited.
- Tersine, R. J. (1994). Principles of inventory and materials management. Prentice Hall.

Example of a thesis using this approach

Thesis reference	Mehtäjärvi, Jermu (2018). Improving the overall effectiveness of a tablet packaging line in a pharmaceutical company
Problem	How to improve performance including quality, speed and availability of tablet packaging line in a pharmaceutical company
Unit of analysis	Tablet packaging line
Tool	Six sigma analysis
Data	OEE measurement data and interviews
Outcome	Analysis and list of suggested improvements for the process

6.3 Computer simulation

Method

Computer simulation is a method to build computer model of a real world industrial problem. Simulation software is used to build the rules and behaviour mechanisms to play the game and then to run the model on a certain time. The key feature of simulation is that you can conduct tests on a virtual world that would not be possible in the real space without large damage.

Figure 3. Factory floor simulation

Questions

- What is the expected capacity of the factory?
- How supply chain behaves in extreme shortage simulation?
- What is the investment payback time for production upgrade?

Tools

- Factory simulation – Kuka Visual Components 3DAutomate
- Agent based simulation – AnyLogic
- Spreadsheet simulation – MS Excel

Data

- Real factory data collected from ERP systems
- Assumptions collected from machine providers, production experts

Important points

- Verification of model – does the model work as intended? Walk-through, animations, testing.
- Validation of the model? – Does the result match with actual with the same initial conditions?

Further reading

- Banks, Jerry; Carson, John S.; Nelson, Barry L.; Nicol, David M. *Discrete-Event System Simulation* Fifth Edition, Upper Saddle River, Pearson Education, Inc. 2010 ISBN 0136062121
- ^ *Schlesinger, S.; et al. (1979). "Terminology for model credibility". Simulation.* ***32*** *(3): 103–104. doi:10.1177/003754977903200304.*
- Sargent, Robert G. "VERIFICATION AND VALIDATION OF SIMULATION MODELS". Proceedings of the 2011 Winter Simulation Conference.

Example of a thesis using this approach

Thesis reference	Sulaymon Abiodun Tajudeen (2018). 3D Simulation and Virtual Reality as Methods for Conceptualization, Designing and Visualization of an Automated Lithium-Ion Battery Factory
Problem	Building a simulation model for a 50 MW battery factory to visualize the operations and space needs
Unit of analysis	A factory
Tool	Kuka Visual Components 3DAutomate
Data	Assumptions recorded and collected from machine providers, expert interviews
Outcome	Model describing the operations and capacities based on assumptions recorded

6.4 Survey

Method

Survey is an examination of opinions from people made by asking questions. This approach is good when human element is concerned and there is no other quantitative data available. The challenge of this approach is that sometime respondents answer what they think they are expected to say or that they do not actually have too much knowledge or experience on the domain. Surveys can be conducted face to face, by using online questionnaires, or over the phone or Skype. Surveys should be well planned prior to execution and tested with a small test group. Structured surveys are often designed by using Likert [1..5] or [1..7] scale questions. Semi-structured interviews support building understanding by letting the respondents to answer more openly to items presented.

Position			Frequency	Percent
.	Missing	System	29	100,0
Co-Pilot	Valid	Over 50 000€	3	6,8
		Over 800 000€	26	59,1
		Over 5 000 000€	15	34,1
		Total	44	100,0
Captain	Valid	Over 800 000€	7	53,8
		Over 5 000 000€	6	46,2
		Total	13	100,0
Instructor	Valid	Over 50 000€	1	9,1
		Over 800 000€	8	72,7
		Over 5 000 000€	2	18,2
		Total	11	100,0

CBAA3 I actively try to make decisions that improve the economy of flying	1	3	7	25	33
CBAA 4 It is possible to operate the plane and gain savings without affecting the safety of flying	0	0	3	29	37
CBAA5 Safety is always my top priority while flying	0	0	0	3	66
CBAA6 Safe flying does not exclude economical flying	0	2	5	27	35
CBAA7 Saving time is usually more important than saving fuel	0	17	33	18	1
CBAA8 Achievin	21	36	9	3	0

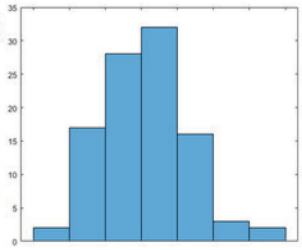


Figure 4. Survey questions, histogram and respondent demographics

Questions

- What is the customer expectations and experience on service quality?
- What is the vendor quality development trend in the past 5 years?
- What are the worker attitudes toward automation of production?

Tools

- Defining population and sample size - https://www.surveysystem.com/sscalc.htm
- Analysis: Statistical software packages: SPSS, SAS, Minitab, RStudio.
    - Correlations

  - Regression models
  - Structural Equation Models (SEM)

- Spreadsheet – MS Excel Stats Add-in

Data

- Defined population and sample sizes should be always estimated and recorded
- Many statistical procedures have assumptions on distribution types, $n < 30$ are often not valid from method point of view

Important points

- Using Likert-scale (1..5) questions is a standard approach, however, it affects on available testing methods, e.g. Mann-U for comparing two samples.
- Combining opinions with some performance data (company revenue) could be useful
- Using only descriptive statistics without further testing is not enough for a MSc. thesis

Further reading

- Rea, L. M., & Parker, R. A. (2014). Designing and conducting survey research: A comprehensive guide. John Wiley & Sons.
- Fowler, F. J., Jr. (2002). Designing questions to be good measures. In In F. J. Fowler, Survey research methods (3rd ed.) (pp. 76-103). Thousand Oaks, CA: Sage. http://wilderdom.com/research/articles/DesigningQuestionsToBeGoodMeasures.html
- Social Research Methods - https://socialresearchmethods.net/kb/survey.php

Example of a thesis using this approach

Thesis reference	Juho Luoma (2016). Pilot Decision and Operating Efficiency. https://osuva.uwasa.fi/handle/10024/2858
Problem	What is the effect of pilot behavior for airplane fuel consumption?
Unit of analysis	Airbus 320 pilot
Tool	Survey made with University Eforms, statistical analysis with SAS
Data	A survey on A320 pilots (n=69) with varying experience. Airbus operating manuals.
Outcome	A model describing how much potential an airline pilot has on fuel consumption and operating expenses and understanding from which operations the variability comes from.

6.5 Process analysis and improvement

Method

Business process re-engineering (BRP) is a systematic approach to analyse current practices, benchmark other organizations and propose improved ways to run the business. Process analysis tools capture the structure of the processes including the steps and key decision-points with key performance indicators which show the planned and actual performance numbers such as costs, time, quality and on-time delivery. Value-stream-mapping, swim-lane diagrams and more specific frameworks such as Supply-Chain-Operations-Reference models (SCOR) can be used.

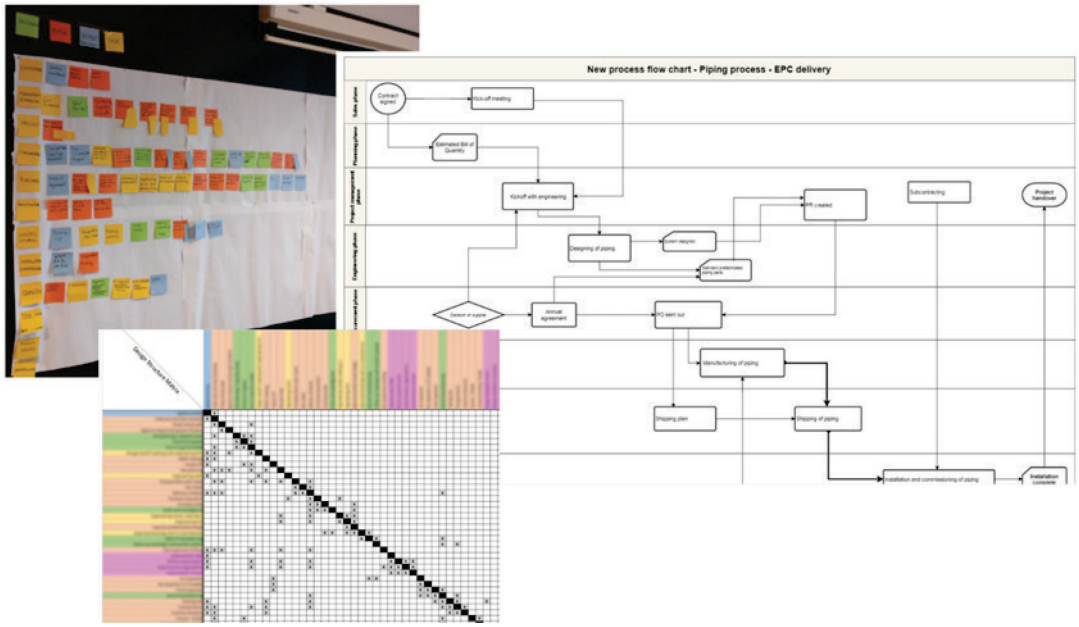


Figure 5. Workshop creating swimlane diagrams and dependency structure matrices

Questions

- What is the current status of the business process?
- How to improve lead-time and quality of the order-fulfilment process?
- How to cut down process steps in service delivery?

Tools

- Swimlane diagrams
- As-is to-be comparison
- Value stream mapping (VSM)
- Design Structure Matrix (DSM)

Data

- Existing process descriptions and KPI historical data from organizations
- Interview sessions for building a commonly agreed process models

Further reading

- Rother, M., & Shook, J. (2003). Learning to see: value stream mapping to add value and eliminate muda. Lean Enterprise Institute.

- Hammer, M., & Champy, J. (1993). Business process reengineering. London: Nicholas Brealey, 444.

Example of a thesis using this approach

Thesis reference	Lindholm, Svante (2018). Value Stream Mapping for Prefabrication of Piping in Projects
Problem	How to improve prefabrication of piping projects?
Unit of analysis	Piping process in a power plant company
Tool	Prorcess charts to describe as-is and to-be situations, Dependency Structure Matrices (DSM)
Data	Workshops conducted in the organization, small survey, process descriptions
Outcome	A new proposed process for handling the communication in piping projects

6.6 Information System Design

Method

Many industrial processes are related to information systems which are used to manage the process. Designing a new system to fulfil the user requirements and organizational objectives requires a systematic approach to analyse the situation and the propose the solution. Information system design is close to process improvements but the expected outcome is the information system implementation or designs for the programmers.

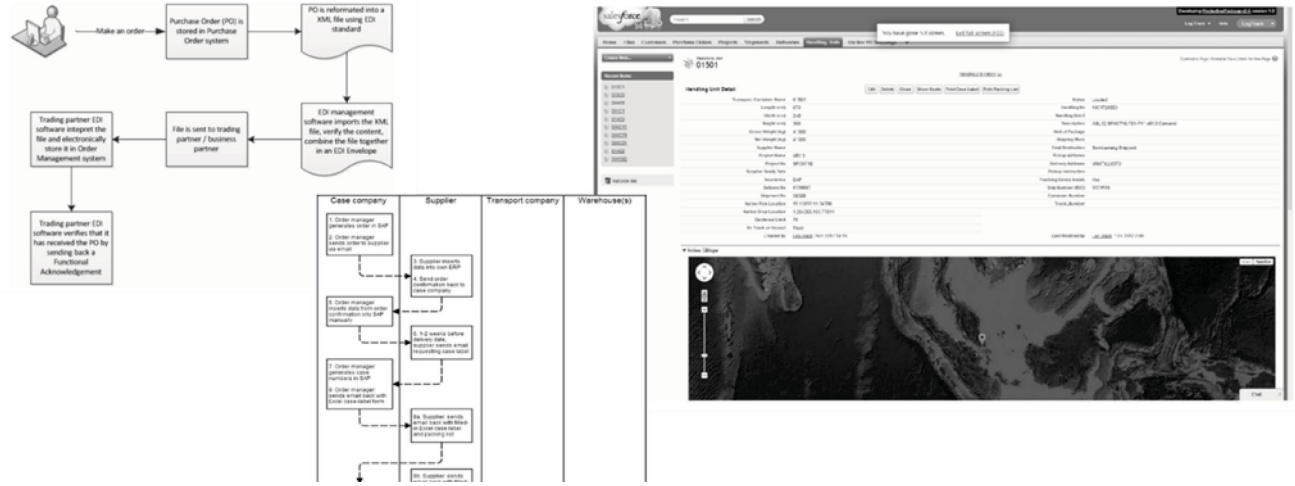


Figure 6. Information systems design and implementation

Questions

- What are the key requirements for an order picking system?
- What key functionality should be included in an manufacturing execution system (MES)?
- How to improve sourcing process by using digitalization?

Tools

- Requirements planning tools
- UML modelling tools: use cases modelling, swim lane diagrams, entity-relationship diagrams
- User interface mock-ups

Data

- User requirements collected in interviews
- Existing data sources and process descriptions
- User feedback surveys

Further reading

- Pohl, K. (2010). Requirements engineering: fundamentals, principles, and techniques. Springer Publishing Company, Incorporated.

- Fowler, M., Kobryn, C., & Scott, K. (2004). UML distilled: a brief guide to the standard object modeling language. Addison-Wesley Professional.

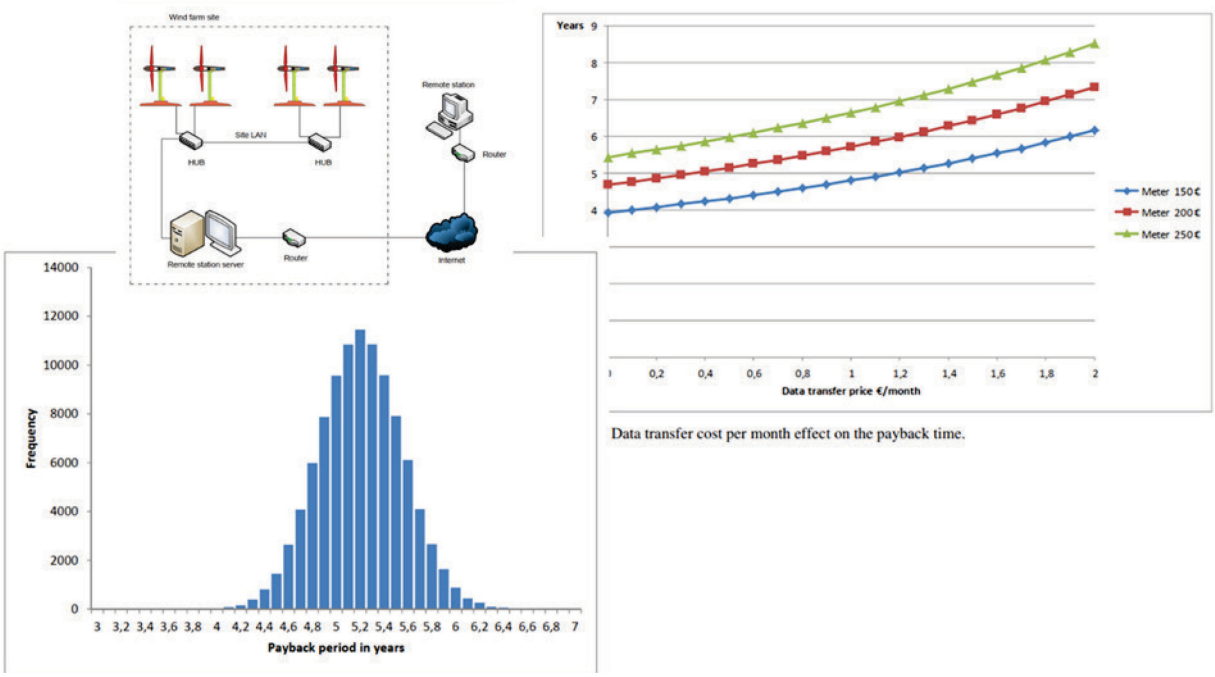
Example of a thesis using this approach

Thesis reference	Nguyen, Duy Phuong (2014). Tracking and tracing portal for project logistics - A Review on the Interconnectivity of EDI, ERP and Cloud-based Systems https://osuva.uwasa.fi/handle/10024/3481
Problem	How to build a common view on supply chain combining various information systems and data flows to show tracking information for project logistics
Unit of analysis	Supply chain and its information system
Tool	UML modelling for analysis and Salesforce.com for implementation
Data	Requirements collected from the organization stakeholders and from the extended enterprise
Outcome	Design and a prototype implementation

6.7 Business case development

Method

Industrial management problems are often related to building new business. New ventures need systematic analyses on markets and profitability as well as established businesses looking for new opportunities or changes. Business case development can include a set of tools varying from business plans, business plan canvases, strategy maps to quantitative approaches where paybacks and profitability is estimated.



Data transfer cost per month effect on the payback time.

Figure 7. Monte carlo simulation of payback analysis

Questions

- What is the expected payback for a factory investment?
- What is the break-even-point for production of a new product?
- How many product variants the company should offer?

Tools

- Investment analysis tools: ROI, NPV, IRR
- Excel with Oracle Ball
- Business plan tools: business plan canvas

Data

- Data collected from sales and operations, services or secondary data sources
- Assumptions recorded on models

Further reading

- Mason, C., & Stark, M. (2004). What do investors look for in a business plan? A comparison of the investment criteria of bankers, venture capitalists and business angels. International small business journal, 22(3), 227-248.

Example of a thesis using this approach

Thesis reference	Heikkilä, Tuomo (2012). Evaluation of business effects of machine to machine systems
Problem	What are the business impacts of an IoT system to various industrial use cases and how to evaluate payback times for these investments?
Unit of analysis	Business cases of automatic meter reading and wind park remote monitoring
Tool	Payback evaluation with investment tools and Monte Carlo simulation
Data	Assumptions collected from expert interviews
Outcome	Payback estimates for the business cases

6.8 Design science

Method

Design Science (DS) is applicable as a methodology to a broad range of management research, which produces actionable knowledge that can be field tested and grounded in 'technological rules'. A DS study could produce knowledge for organisational design (as an example, identifying the contexts in which strategic change must be incremental rather than radical). One area of management research that has considered DS is Operations Management (OM).

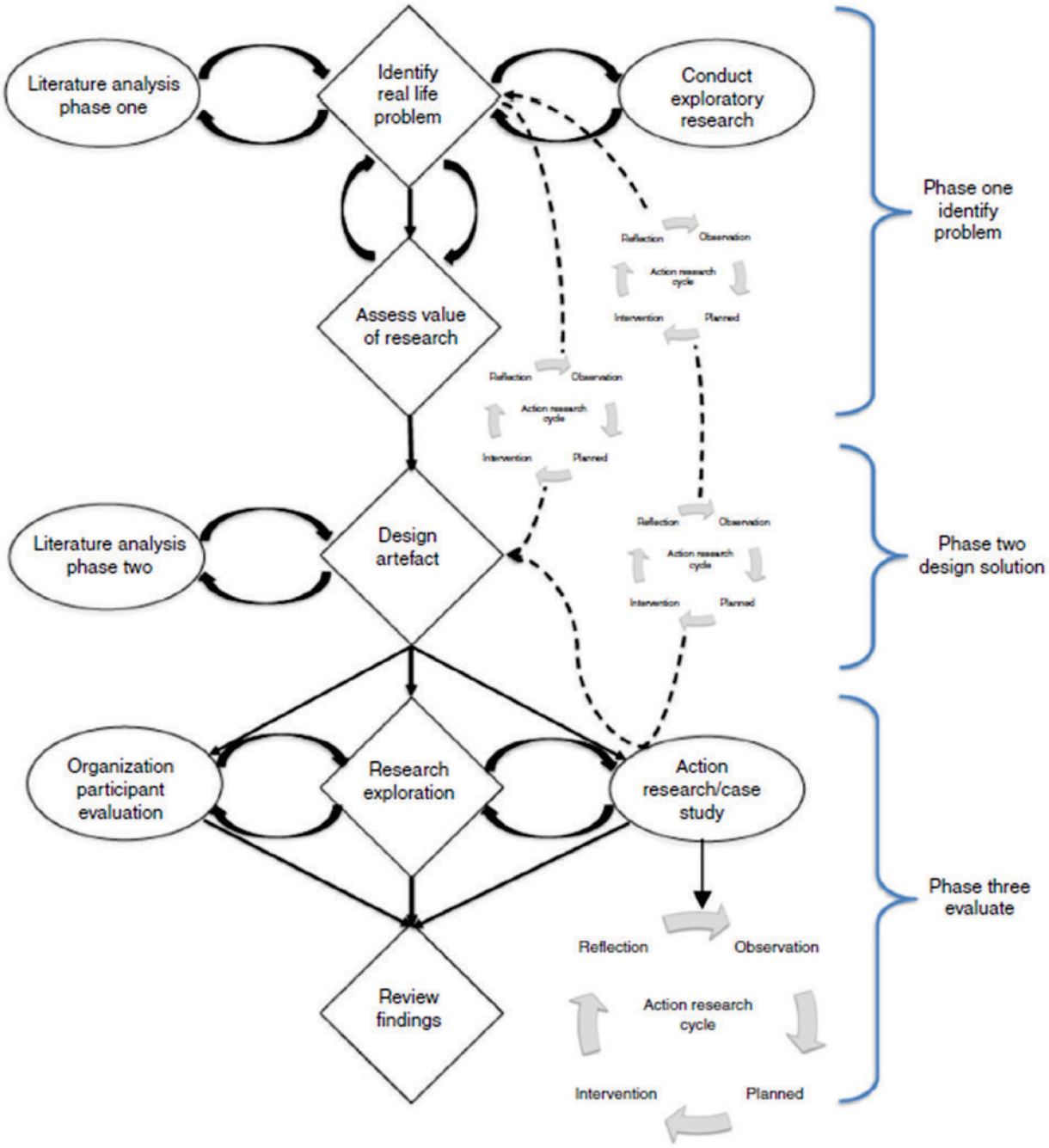


Figure 8. Design science research with action research cycles framework

Questions

It is suggested that vital research questions, and the utility of designed systems, cannot be researched without engaging with the natural environment. A more formal DS approach

in OM can help with substantive or mid-range theories[1]. This is theory that cannot necessarily be generalized beyond the context, but can be transferred to other contexts that exhibit similar characteristics. OM can be perceived as instances of similar context, for example, the behaviour of fast-moving consumer goods supply chains may be explainable by a mid-range theory (O'Keefe, 2015). The use of DS methodology is illustrated in the table below.

Tool steps (adapted from)

1. Problem identification and motivation

2. Define the objectives for solution

3. Design and development

4. Testing and demonstration

5. Evaluation

6. Generation of theory

DS is originally developed by Simon for decades ago and used especially during the last ten years in the field of information systems studies. DS is can be also combined with action research, which is seen in the picture in the next page. In this approach, there are the following phases in the DS:

(1) Identifying of a problem: a) literature analysis and exploratory research and b) assessment of the value of literature

(2) Designing a solution: literature analysis (phase 2)

(3) Evaluation: a) organization participant evaluation and action research/case study, b) review of findings

Further reading

- O'Keefe, R. (2015). Design Science, the design of systems and Operational Research: back to the future? Journal of the Operational Research Society (2014) 65, 673–684

[1] For further information, see the article of Stank et al (2017) explaining middle range theories (MRT) compared to general theories. To illuminate the difference, general theories are more focused on customer services in general, while MRT's are focused on more specific issues, like logistic customer services (https://onlinelibrary.wiley.com/doi/pdf/10.1111/jbl.12151).

- Schultz, A.L. (2017). Integrating lean and visual management in facilities management using design science and action research. Built Environment Project and Asset Management Vol. 7 No. 3, 2017 pp. 300-312

- McCutcheon, D. M., & Meredith, J. R. (1993). Conducting case study research in operations management. Journal of Operations Management, 11(3), 239-256.

- Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. Journal of management information systems, 24(3), 45-77.

- Flynn, B. B., Sakakibara, S., Schroeder, R. G., Bates, K. A., & Flynn, E. J. (1990). Empirical research methods in operations management. Journal of operations management, 9(2), 250-284.

Example of a thesis using this kind of approach

Thesis reference	Front End of Innovation in Industrial Organization https://osuva.uwasa.fi/handle/10024/3024
Problem	How to be successful in the front end of innovation in an industrial organization?
Unit of analysis	A firm
Tool	Insight matrix and Front End Innovation questionnaire
Data	Data collected in workshops as well as with questionnaire
Outcome	A model for front end of innovation in an industrial organization

7 PRACTICALITIES

7.1 Working with a company

If you are working successfully with a thesis topic from a company and perhaps they are paying you some lump sum of money or you can allocate some working hours for the thesis project, you need to keep your company up to date on your thesis progress.

- Organise a kick off meeting with a company.
- Communicate frequently with your company, at least once every two weeks to update your current progress.
- Visit physically sites and meet people, this is a great opportunity to build connections which may become very relevant in your later steps.
- Organise a result presentation meeting once your thesis results are close to final. Listen the feedback and adjust accordingly.
- Take review comments seriously. Remember that the purpose of review is to improve your work. Good quality is more important than fast graduation.
- Ask a final permission to publish your work to ensure that you have not released any classified information.

7.2 Writing an abstract

Abstract is a summary of the thesis. It should include at least a sentence of each chapter. It is not only an intro part for the work but also the method should be opened up and key results should be clearly presented. Structured abstract, along with the Emerald journal style could be written by having a sentence or two on each of these items.

(1) What is the topic of your work?

(2) Problem statement

(3) What earlier or related research has been conducted on this topic?

(4) What is the method, data source and sample size of your study?

(5) What are the findings from your work?

(6) What is the impact of the findings?

As you can see the abstract structure follows the structure of the thesis very much. Abstract will be later tagged with keywords, which help users to search matching works.

7.3 Plagiarism check

The final version of the thesis will be submitted for TurnItIn analysis. This is to ensure that you have not forgotten any raw text from other sources. Your supervisor will conduct the analysis, but as the author of the text, you are solely responsible for your text. Keep in mind that as thesis works are public documents, any copied text will be found in the long run and nothing ever can be deleted from Internet. Some principles suggested:

- Always cite the original author in the text
- Do not copy directly more than two words from a source without using parenthesis and citation
- Images copied directly from other sources require a permission from the original author or copyright holder such as publisher of the article
- For clarification, you can mark you own figures with text (author).

7.4 Finalising the thesis and submission

Finally, when the actual research work and reporting has been conducting and it is time to get things finalized, ensure completion of the following items:

(1) Use latest version of the university style guide, which is maintained at https://uva.libguides.com/writingguidelines

(2) Proofread your text, use your friends, family or anyone who is not familiar with your text

(3) Ensure that there is no copied text anywhere

(4) Attend seminars and complete two presentations

(5) Final version should be uploaded to Moodle and plagiarism check. No more than three direct word quotations should appear without using parenthesis. Always cite the source the original cites.

(6) Once thesis has been submitted for evaluation, which will be completed by two supervisors and approved by the dean, you can register to a maturity text. This test is an e-exam where two questions are asked from your thesis. The purpose is to ensure that you have written your text and are able to answer the question properly.

(7) The evaluation process takes maximum 4 weeks.

Yes/no checklist for thesis submission

1. Abstract written?
2. Permission from company to publish your data?
3. Final proofreading done?
4. Plagiarism check approved by your supervisor?
5. Submit final “hard-copy”

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