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KAUNAS FACULTY

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THE PROCEDURE FOR MASTER'S THESIS PREPARATION
Methodological guidelines

For the students of Business Informatics (**62109P101**) study programme at VU KnF Institute of Applied Informatics

KAUNAS
2017

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Considered and approved for publishing by the Council of Kaunas Faculty of Vilnius University (08/11/2017, protocol No. 12)

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INTRODUCTION

The methodological guidelines are intended for the preparation of Master's theses for Business Informatics students at the Institute of Applied Informatics (IAI), Kaunas Faculty (KnF), Vilnius University.

This publication describes the strategy for preparing the final thesis and the course of thesis preparation from the formulation of the topic to defence. The requirements for the preparation of structural parts of the thesis are presented, recommendations, general rules and examples are given for the presentation of textual and illustrative elements. The procedures of reporting during intermediate stages of the final thesis preparation, thesis submission to the scientific board, and defence are described. The methodical guidelines present the requirements for the Master's thesis and describe the course of the Master's thesis preparation. The Scientific Board will evaluate individual stages of the final thesis preparation and the final thesis itself in accordance with the provisions set out in these methodological guidelines. We hope that these methodological guidelines will help Master's students avoid methodological and formatting mistakes during thesis preparation and will allow them to concentrate on the content of their work.

We are grateful to all the employees of the Institute of Applied Informatics, Kaunas Faculty, Vilnius University, who helped to prepare these guidelines.

1. STRATEGY AND OBJECTIVES OF MASTER'S THESIS PREPARATION

The Study Programme Committee (hereinafter – the Committee), which is responsible for a successful implementation of the study programme, is an academic study programme management unit operating in Vilnius University. Its purpose is to manage an accredited study programme (hereinafter – SP) or several accredited SPs in the same field of study. The composition of the Committee, with the exception of students' representatives, is approved by the faculty Council on the proposal of the dean. Students' representatives in the SP committee are delegated by the Student Representative Council of the University. The chairman of the Committee is approved by the Senate on the proposal of the council of the core academic unit. In its activities, the Committee follows the Statute of Vilnius University, VU Study Regulations, VU Study Programme Regulations, description of a relevant study field, other relevant legal acts, VU documents, and these Guidelines. The aim of the SP Committee is to ensure the competitiveness of the study programme, the relevance of the study outcomes and qualitative achievement of these outcomes by combining opinions and needs of the persons concerned as well as best practices.

Business Informatics Master's degree programme is a second cycle degree programme which seeks to integrate fundamental knowledge and the latest advances in the fields of information technology and the development and management of information systems.

Upon successful completion of this Master's degree study programme (study area – information sciences, study field – information systems), managed by the Institute of Applied Informatics, Kaunas Faculty, Vilnius University, the students are awarded a Master's Degree in Information Sciences. This qualification-certifying diploma is awarded only when the programme's requirements are fully met and a Master's thesis (MT) is defended. **Master's thesis is an independent scientific qualification work, which deals with the problem of the development of information systems or application of information technologies, the problem being relevant both scientifically and in practice.**

General objectives of the Master's thesis in Business Informatics:

1.   To prepare the thesis based on general research methodology, to be able to analyse and critically evaluate scientific literature, to summarise practical findings, to draw conclusions, to make recommendations.

2.   To demonstrate theoretical and practical knowledge in informatics, mathematical calculations, optimisation methods, information systems, business process analysis and the development of information products and integrated solutions.

3.   To be able to summarise the knowledge and propose a solution to the problem in the Master's thesis – to offer a conceptual solution, theoretical or applied method and to check the possibilities of its practical implementation.

In order to obtain **a Master's Degree in Information Sciences**, the students of Business Informatics Master's study programme must demonstrate the acquired qualification in business process modelling, experimentation and programming as well as substantiate the reality and functionality of the prototype created in a computerised environment.

Master's students shall choose the topic of the final thesis at the beginning of the second semester, until October. The topic is chosen from a list proposed by the Institute of Applied Informatics, which is in line with the SPC and reflects scientific interests of scientific advisers. Master's students have the right to offer their own topic, however, the topic must be coordinated with the scientific adviser. Fields of research at VU KnF Department of Informatics:

- The application of performance and management models for knowledge-based information systems engineering;
- The development, research and application of intelligent system algorithms for modelling of financial markets, e-business, management and marketing systems;
- Human-computer interaction in business information systems.

During thesis preparation, the wording of the topic often needs to be clarified and corrected, therefore, at the beginning only a preliminary topic is chosen after discussing it with the scientific adviser. In formulating the title of the topic, it is necessary to pay attention to the general recommendations and requirements for the final thesis topics set by Vu KnF Institute of Applied Informatics:

- ***The topic must be relevant,*** i.e. significant both scientifically and in practice.
- ***The topic must be original,*** i.e. it should not coincide with the topics of previous graduates. If several students carry out research of the same problematic area or perform a continuous research, their research titles must be different, i.e. they should reflect the selected aspect of individual research.
- ***The researcher should find the topic interesting***, i.e. the topic should meet personal scientific interests and needs of the research object (business branch, company, scientific field, etc.).

Before the topic is formulated, it is necessary to clearly set the boundaries of the research. In each thesis, only a definite part of the broader problem (a group of issues) may be considered, so that the topic can be properly understood and analysed. Thus, students should not choose a very broad topic as they will only be able to overview it superficially during a limited period designated for the preparation of a final thesis.

It is necessary to take into account **the possibilities of realisation of the topic**, to determine whether you will be able to review enough scientific literature, obtain the necessary data, apply the chosen methods and devote enough time to study the topic and prepare a software solution.

A very important part of the final thesis preparation is *the review of scientific and technical literature*. At the initial stages, literature analysis helps to get acquainted with the work performed in the chosen scientific field, formulate the topic, provide research methods, draw up a plan for thesis preparation. The analysis of scientific sources will help you find out about the latest research and its results, adjust your work if necessary, and find out whether your findings are corroborative.

When beginning to analyse the topic of the final thesis, the author of the thesis should get acquainted with *general* literary sources, textbooks, monographs, dissertations, collections of scientific works or materials of scientific conferences of the chosen field. It is necessary to understand the research problem, to evaluate its scientific and practical importance, to be able to distinguish the groups of researchers who have studied this problem, their attitudes and proposed solutions to the problem. This will help

select the specific literature (articles, abstracts, annotations, sets of statistics, etc.) aimed at discussing the research problem *into greater detail*.

When searching for literature, it is recommended to use material and electronic resources of VU and VU KnF libraries (scientific databases, electronic catalogues, electronic books, etc.), the links to which are available on the website of Vilnius University Library at https://biblioteka.vu.lt/istekliai/. The majority of electronic resources are available from the workstations of Vilnius University computer network or by installing a virtual private network (VPN) on your computer.

When analysing literature, it is recommended to prepare an electronic or "paper" card index of literary sources. Card index presented below may be used for this purpose (Table 1). However, card index can only serve as an analytical tool and cannot substitute literature review.

Table 1

Card index of literary sources

Surname of the author(s), name(s) initials	Literary source title	Literary source type (monograph, scientific article, etc.)	Literary source data (for a book – publishing house, city, year; number of pages, for a journal – title, year, issue, article pages)	A brief annotation of considered issues
1	2	3	4	5

Source: created by the authors.

The information gathered in this way will help find literary sources that have already been analysed, will facilitate summarising, classification of information, will be useful in citing, referencing, and compiling the list of references. When compiling card index of literary sources, it is recommended to write a detailed annotation as it can be useful in writing literature review in the analytical part of the thesis.

When preparing the final thesis in business informatics, it is necessary to assess and compare *software or other solutions* already developed by different companies as well as their functions and technologies and methods used. This will help formulate the thesis topic more precisely and to substantiate its relevance. Commercial information systems and software products are not generally available free of charge, therefore, it is necessary to explore and use various possibilities for planning the development process of the final thesis:

- It is recommended to find out what software products for designing, developing and programming computerised systems as well as for enterprise accounting, statistical analysis, modelling, and system design are installed in the computer network.
- If the topic of the thesis is chosen with regard to the interests of the company with which the student cooperates or where he/she does his/her traineeship, it is recommended to examine and use the systems developed there.
- It is expedient to use free demo versions provided by the companies for your analysis.

The following chapters of this methodological publication provide detailed recommendations and requirements for preparing Master's thesis (Chapter 2) and qualitative thesis descriptions (Chapter 3), and for defending the thesis successfully (Chapter 4).

2. STRUCTURE AND CONTENT OF MASTER'S THESIS

In this chapter the structure of Master's thesis and the content of the thesis description parts as well as the preparation plan of the thesis are discussed.

A successfully prepared Master's thesis ought to:

- **reveal** the relevance of the analysed problem and its scientific and practical significance;
- **reflect** the connection between the analysed problem and the issues of information systems as well as the significance of the preparation of the thesis to information sciences;
- **clearly define** the object, aim and objectives of the thesis;
- **analyse, summarise and assess** the theoretical material and data, allowing to comprehensively display the selected topic, and review methods for the solution of the problem that are indicated in foreign and Lithuanian scientific literature;
- **present original proposals** to solve the problem: models, programmes, algorithms, calculation methods, recommendations, forecasts, projects, designs, topologies, integration means, etc.;
- **assess** the proposed solution in regard to the analysed works and already existing solutions, identify advantages and disadvantages and propose recommendations for the further elaboration of the accomplished thesis;
- **formulate** conclusions, discuss the results obtained by reaching the aim of the thesis and by accomplishing the set out objectives;
- **follow** the requirements of the thesis structure, terms, technical formatting and the order of constituting lists of references and sources.

Master's thesis has to be accomplished by the date indicated by the VU KnF Institute of Applied Informatics and publicly defended.

2.1 The structure of Master's thesis

The structure and content of Master's thesis have to comprehensively reflect the research problem and its solution. The main parts of the structure are determined by the VU KnF Institute of Applied Informatics, while a detailed structure of the thesis is discussed by the scientific adviser and Master's student.

Standard parts of Master's thesis:
- introduction;
- theoretical/analytical chapter;
- proposed solution methodology;
- experimental chapter;
- conclusions and recommendations.

Additional parts of the thesis: title pages, contents, list of abbreviations, list of figures and tables, summary in a foreign language and annexes.

The recommended **length of the thesis** is about 250–300 thousand characters (not including the list of references and annexes). When writing a Master's thesis it is essential to consider its continuity. Figure 1 displays a scheme of the structural parts of Master's thesis and connections among them.

TOPIC
(its formulation reflects what will be done to reach the aim)
Recommended words for the title of the topic: "research", "modelling", "assessment", "optimisation".

INTRODUCTION
relevance of the research problem;
level of the existing research on the problem;
scientific problem;
object of the thesis;
aim of the thesis (defines what will be done with the object);
objectives of the thesis:
theoretical/analytical: analysis of the selected problem by summarising the achievements, methods and models of the applied scientific area (business or IT);
proposal; of a solution: grounding and description of the solution method of the problem suggested by the Master's student;
experimental/practical: modelling, empirical research and examination of the potential to apply the suggested solution.
brief description of the structure;
literary sources used in the thesis;
thesis and research methods;
theoretical significance of the results;
practical significance of the results;
difficulties, application limitations (if any);
thesis structure and length.

THEORETICAL/ANALYTICAL CHAPTER

METHODOLOGY OF
THE SUGGESTED SOLUTION

EXPERIMENTAL CHAPTER:
empirical research;
IT model analysis;
experiment;
prototype for method demonstration.

CONCLUSIONS AND RECOMMENDATIONS
The results, obtained by the author, as well as differences from the previously presented data are described.
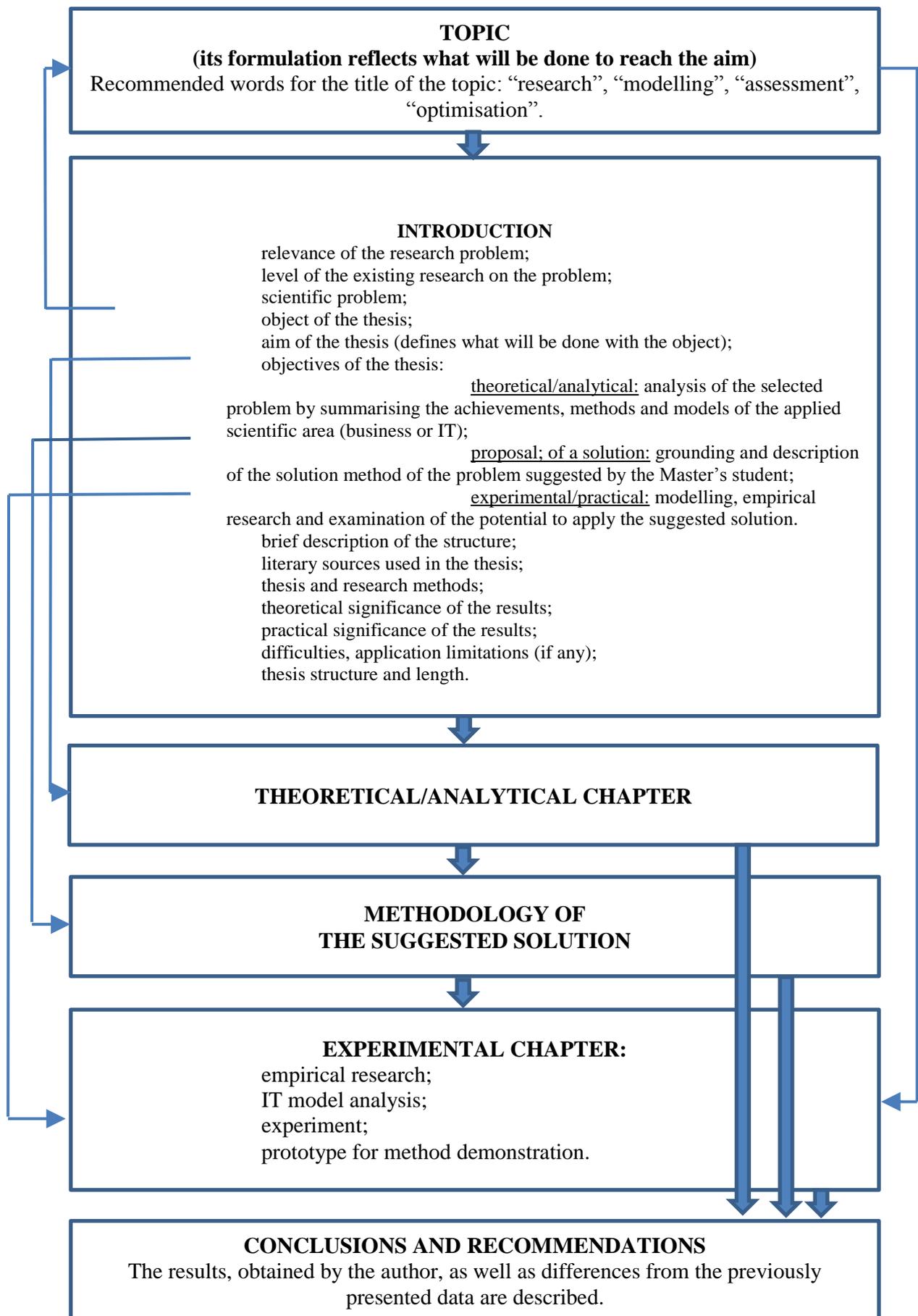
Figure 1. Structural parts of Master's thesis and connections among them

In accordance with Figure 1, which presents a **logical structure** of Master's thesis, the thesis is started by selecting a **scientific problem**. A broader scientific problem is usually chosen, which covers the majority of the related issues and possible directions of the research. Afterwards, aspects of this problem analysed by various scientific branches (i.e. management, creation of information systems, informatics, applied fields such as finance market, language signals, etc.) as well as questions of this problematic field that are insufficiently analysed or not analysed at all are overviewed. For further research the Master's student selects a narrower, specific aspect of the scientific problem which could be dealt with by applying methods of business information system creation and informatics as well as their models and programmable solutions: this is the **aim** of the final thesis. Regarding the selected aim of the thesis, a tentative **topic** of the thesis is formulated. In the **introduction**, the reasoning for the analysis of the scientific problem is presented, clear formulations of the problem, object, aim and objectives are presented and practical and theoretical **relevance** of the intended research is justified. After finishing the Master's thesis the introduction is complemented by discussing the results of the final thesis, their significance to the theory and business practice. In the **theoretical/analytical chapter**, methods and models presented in the scientific literature and empirical research that analyse the problem from various attitudes and suggest means to solve it are analysed in detail. The advantages and limitations of the existing solutions are assessed and a possible innovative solution to the problem is substantiated. In accordance to the results of the theoretical/analytical chapter, the research methodology suggested by the author is described in the **chapter of the proposed solution methodology**; in addition, the existing methods or methods suggested by the author as well as conception models and calculation algorithms that will be employed to solve the problem of the thesis are presented in detail. After suggesting the theoretical method of solving the problem, the means to justify and examine the method or concept model proposed by the author are selected in the **experimental chapter of the final thesis**. The conducted empirical research, experiments as well as testing by employing a demonstrative data collection or by creating a model prototype are described. In **conclusions**, the results obtained during the theoretical analysis and experimental research of the thesis of the Master's student, their novelty, the essence of the proposed solution, positive and negative features as well as application limitations in comparison to previous solutions are described.

The structural parts of the Master's thesis are coherently arranged in accordance with the described order. Further on the recommendations and requirements for their content and formation are presented.

Initial pages.

2 title pages. Formatted according to the example presented in Annex 1 and Annex 1 (continued).

Contents. A detailed list of the parts of the thesis is presented in the contents (structure presented in Annex 2). Lists of figures, tables and abbreviations as well as the summary, introduction, conclusions, list of references and annexes are put in the contents as independent structural parts. These parts are not numerated. Chapters and subchapters are numbered in Arabic numbers, i.e., subchapter 4.4 (Annex 2). Names of the chapters and subchapters have to be short, clear and correspond to the essence of the problem. It is not recommended to create a separate chapter, if it is shorter than one page.

List of tables and figures. In one page (or separate pages), an individual list of tables and figures is presented and the page number is indicated (Annex 3).

List of abbreviations. Abbreviations used in the thesis as well as their definitions are presented. In this list, rarely used words, complicated concepts, terms and markings are explained (Annex 3).

Summary in a different foreign language. Summary is a short report of the essence of the Master's thesis in one of these foreign languages: English, German or French. If the thesis is written in a foreign language, the summary has to be presented in Lithuanian. It has to coherently reflect the bellow mentioned elements (An example of a summary is presented in Annex 4):

- name and surname of the author;
- year when the thesis is written;
- title of the topic;
- words: Master's thesis (MT);
- preparation place of the thesis, the name of the school of higher education, title of the faculty and institute;
- length of the thesis (p.).
- Then a brief description of the thesis is presented in which this information is indicated:
- the aim and objectives of the thesis;
- research methodology;
- specific results of the thesis;
- main conclusions;
- length of the thesis in pages (not including the list of tables and figures, list of abbreviations, list of references and annexes) as well as the number of tables and figures.

The summary cannot exceed one printed page.

Introduction. It is a part of Master's thesis in which the main features of the accomplished thesis are described and connections among the results obtained in different parts of the thesis are highlighted. The relevance and significance of the analysed problem to the theory, practice and the selected research object (enterprise, organisation) should be presented in the introduction. The below mentioned issues are briefly discussed in the introduction.

- *Relevance.* In this section, the motives of selecting the topic are revealed by indicating some of their types: **relevance to the enterprise** (i.e. specific needs of the enterprise to analyse the problem that is relevant to it, to propose solutions for this problem, to reveal the reserves for the development of processes or methods of the selected area), **relevance to science** (i.e. it is analysed how the new methods could be applied to increase the activity processes or business efficiency and to reach decisions), **relevance to practice** (i.e. problems that are constantly encountered by the professionals of the researched area, features that are missing in the existing solutions).

- *The extent of research on the subject.* In this section of the introduction, aspects applied for the analysis of the problem, conducted research as well as already developed systems and methods are briefly overviewed. It is essential to present surnames of the authors who analysed the research issue, their research field as well as groups and products of programmable solutions.

The relevance of the topic is summarised by identifying the **problem** that will be further on analysed in the thesis. The problem is commonly formulated as a question that expresses a lack of effective methods, insufficiency of conducted

research, disadvantages of the conceptual models or insufficient knowledge of factors that impact the researched area (markets, enterprises and processes).

- *Object of the thesis*. Here it is identified what will be analysed in the thesis: individuals, groups, organisations, information systems, algorithms or interaction of objects and causal associations.
- *Aim of the thesis.* In the aim, the question to which the selected research of the object of the thesis should answer and the part of the chosen problem or a group of issues that are planned to be solved are expressed. The *aim* should be brief and formed in one sentence. These words are used when formulating the aim of the thesis: *to analyse, examine, validate, inspect, create a model* and *propose a method*. These terms are not recommended, when formulating the aim: *to learn, find out, discover* and *prove*. The title of the thesis has to *correspond* to the *aim*, reflect the research object and reveal the result that is desired to be reached. The aim should be reached only after coherently conducting separate stages of MT. Therefore, *objectives* are formulated that reflect the theoretical and practical stages of reaching this aim and research methods applied in these stages. *Objectives of the thesis* express the steps that you have to take in order to solve the problem and to reach the aim. For Master's thesis 4-6 brief and precise objectives are enough. Usually, 1-2 theoretical/analytical objectives (performed in the theoretical/analytical chapter), 1-2 objectives of the proposed solution methodology (performed in the methodology chapter) and 1-2 research or experimental objectives in which the methods to assess the obtained results are introduced. The results of all of the solutions of the objectives have to be reflected in the conclusion and recommendation part of the Master's thesis.

The description of the objectives is formulated as shown below:

To reach the aim the following objectives have been set out:
- *In accordance to..................., to specify....*
- *To analyse........ and to summarise*
- *To propose a method, to create a subsystem ...*
- *After the assessment..........., to formulate....*
- *To analyse...., to conduct an experiment ..., to verify the calculations...*

- *Structure of the thesis.* The structure of the thesis is outlined by the object, aim and objectives of the thesis. In this part, the logical structure of the thesis is briefly described, titles of the main chapters are presented and questions examined in these chapters are concisely analysed.
- *Literary sources used in the thesis.* The sources used when writing a thesis are briefly presented. The surnames of the main authors may be indicated. The types of sources used when preparing the thesis as well as their novelty, categories (scholarly literature of Lithuanian and foreign authors, descriptions of software products, monographs, manuals, articles, research data) are described. The ratio of published and internet sources is indicated.
- *The thesis and research methods.* The research methods and the ways of their application (e.g. analysis and synthesis of scholarly literature, solution modelling, creation of a model, questionnaire survey, quantitative analysis, methods of strategic analysis, factor analysis, correlative analysis, experimental measurements, methods of statistical analysis, etc.) are presented.
- *Theoretical and practical significance of the results.* The main theoretical and practical results of the thesis are briefly presented. For instance, what needs of the

company have been fully or partially met by applying the method, model or software solution proposed by the author.

- ***Limitations and obstacles of the thesis.*** The obstacles that the author faced when writing the thesis, the reasons why he/she was unable to implement all his/her ideas, the limitations of the application of proposed solution are described.
- ***Structure and scope of the thesis.*** The number of parts, pages, tables, figures and appendices is indicated.
- If when writing a Master's thesis the author published or prepared any publications, they are indicated in the introduction after establishing the practical significance of the thesis. This part is called **verification of results.**

The scope of introduction is 1.5–2 pages.

<u>**Body text.**</u> Its structure and content are determined by the topic and chosen methodology, therefore, the thesis description must be coordinated with the scientific adviser.

Each part of the thesis should contribute to reaching the aim and consistently solve the tasks formulated. Thus, the tasks should be formulated in such a way so that the researched issues would be analysed in great depth, summarised and evaluated according to the chosen criteria. It is recommended to start each chapter with an introductory text, which briefly describes what is being discussed in this chapter, what results are to be achieved. Every chapter should end with a summary of the results obtained and an explanation how these results will be used in the next chapter. Concluding paragraphs demonstrate the completeness of chapters, help to consistently disclose the topic, avoid insignificant subchapters where no results are obtained. Chapter conclusions reveal whether the tasks formulated in the thesis have been fulfilled, or the results described in the chapter have helped to achieve the aim. Chapter results are used in writing the chapter of conclusions and recommendations.

Theoretical/analytical chapter is dedicated to problem analysis from a theoretical point of view. This chapter analysis models and methods published in empirical studies and scientific literature, which investigate the problem in different perspectives, and present measures to solve it. Theoretical material (from scientific articles, monographs, academic publications) collected by the Master's student must form the basis of this chapter. It must demonstrate the student's mastery of erudition, his/her intellectual capacity, ability to apply the knowledge of information systems and information technology to solve the problem.

Literature review should provide a comprehensive picture of the state of research problem, reveal the directions for further research, help assess the benefits and limitations of existing solutions, and substantiate possible innovative solutions to the problem. The theoretical/analytical chapter should help answer the following questions:

- What *scientific literature* (of what field) explores thesis-related issues:
  - what issues have already been partially solved, what are the theoretical methods, models, algorithms, calculations applied;
  - what solutions proposed in literature do not meet the needs, and why;
  - what issues were not addressed by researchers or to what issues solution methods were not proposed;
  - what scientists worked in this field and how they addressed the problem.
- What findings of *empirical research* and *technical reports* published in scientific literature describe the state of affairs, problems and solutions of the issues related to the thesis topic.

- What *software products*, *information solutions*, which are at least partially suitable for solving the researched issues, may be used:
  - what criteria are chosen for evaluation of these products;
  - what are the characteristics, limitations, benefits and drawbacks of researched systems.

Material grouping and structure of the theoretical/analytical chapter. Before starting to write the theoretical chapter, first of all it is necessary to thoroughly review all available scientific material, add new literary sources, and group them according to the most important aspects. The material grouped in this way will help formulate ideas more rationally, purposefully. Scientific literature may be grouped according to the *principle of historicity* (revealing the influence of IT or other fields of science on the research problem), *principle of thematic connection* (revealing the influence of various groups of scientists, views, theories, and conceptions). If *literature on the researched topic is insufficient or there is none*, theoretical analysis should be performed. Theoretical analysis evaluates the state of the research *indirectly* related to the researched field, revealing the assumptions about which technological, managerial or other kind of reasons prevented finding solutions to the research problem.

Content and requirements of the theoretical/analytical chapter. The theoretical chapter should describe in detail the research object: to explain the main concepts and terms and identify the research field. This chapter overviews the main literature related to the research objects, as well as acknowledged theories, provisions, conceptions, arguments, calculation methods, software products already developed and applied in the research field. The chapter compares the applied methods, reveals the fields of their application, highlights contradictions, incompleteness, gaps. The theoretical chapter should be based not only on recognised works and experience of foreign scientists, but also the extent of research on the subject and research performed in Lithuania. **The analysis of theoretical material** is summarised by demonstrating the author's relation to scientific literature and research data, i.e. based on theoretical tasks of the thesis the author provides more precise definitions, justifies the assumptions for new solution methods, gives classification of methods, highlights new ways of method integration and modification. In this chapter the author proposes the criteria that, in his/her opinion, are necessary for models and methods used to solve the problem. In the following chapters, the author should propose a solution that meets the evaluation criteria, test it experimentally and provide research findings in the conclusions.

Theoretical/analytical chapter comprises about one third of the thesis (approximately 20 pages).

Chapter of the proposed solution methodology. It is difficult to provide specific methodological guidelines or recommendations for writing this chapter (excluding those that have already been mentioned when discussing other aspects of thesis writing), since the topics of thesis vary greatly. Therefore, we restrict ourselves to providing more general guidelines.

This chapter is dedicated to a detailed description of the problem solution methodology, models, architecture or calculation algorithms proposed by the author. The solution provided by the author should ensure the most effective way of reaching the aim of the thesis, obtaining most effective results, which can be assessed and compared with the current ones.

In the majority of cases, when writing a proposed solution methodology chapter the Master's student prepares his/her *theoretical method or conceptual model* to solve the

problem by applying the methods of deduction, i.e. having summarised the works of foreign and Lithuanian authors and current software solutions in his/her theoretical/analytical part, the author proposes a method for solving the problem raised in the thesis and reveals the advantages of the above-mentioned method. If the analysis carried out in the theoretical/analytical part of the thesis is insufficient to formulate the theoretical model, inductive method is applied, i.e. empirical research is carried out, research hypotheses are raised, research methodology is described, primary and secondary information is collected and, having summarised the findings of this research, structural parts of the new model are proposed, algorithms or integrated problem-solving methods are formulated. The proposed method is described in detail, illustrated by formulas and tables, its structure, functionality is structurally depicted in conceptual schemes, algorithms and software design computerised tools selected by the author.

Experimental chapter is dedicated to the selection of means to validate and verify the suitability of the proposed solution. Based on the topic of the thesis, the Master's student should select suitable methods of experiment validation and apply them skilfully. Computerised means, i.e. mathematical, statistical data processing tools, are applied to process the findings. The methods that are most frequently employed in experimental chapter are quantitative empirical research, qualitative research, case analysis, surveys, experiments, testing by using sample data sets, creation of a model prototype. The literature of scholarly research methodology is rich with recommendations on how to apply different experimental research methods. General recommendations are provided bellow.

Experimental research is carried out and described as follows:
1. Data collection;
2. Data processing and analysis;
3. Verification of the suitability of findings;
4. Analysis, interpretation and summary of the findings.

Data collection includes the following aspects:

- Tools and means for data collection, i.e. questionnaires, data collection templates, devices for recording signals or video material, interview questions, etc.
- Status of participation – the researcher can be the participant of the researched case, a partial participant-observer (if he/she does not have the same qualification or status as the researched) or an observer of the situation. The credibility of research findings depends on the status of the researcher (for instance, if the researcher works in the researched company, his/her conclusions are reached in the context of better understanding of company's activities. If he/she is only an observer, his/her conclusions are based on a survey which covers a short observation period).
- Data sources – where and how the data necessary for the experiment or survey were obtained.
- Data validity – whether the data are sufficient to completely analyse the object, whether the data are interpreted correctly. The validity of conclusions increases if the author of the thesis carries out a comparative research on a different case, company or covering a longer period of time based on the research findings.
- External data validity (generalisation) – whether it is possible to use research findings to solve similar problems.

- Data quantity, data validity – the credibility of the experiment and quantitative research is guaranteed by a sufficient and well-grounded research sample that reflects all the groups of researched population. The sufficiency of qualitative research is guaranteed by a comprehensive, well-rounded case description, multiple case comparison.
- Research place, time, start and end dates – the place and date of the research, the period of data used for the experiment are indicated.
- Research limitations – the rules that were followed when collecting the data, the obstacles encountered when carrying out the research, the type of necessary data that the researcher failed to collect due to objective reasons (ethical issues, secret information, patents, company's internal procedures to ensure confidentiality).

Data analysis includes the following aspects:
- Analysis methodology – methods, algorithms, procedures or specific sequence of actions created by the author for the processing and research of data.
- Analysis tools – applied computerised analysis tools, software or specialised productive software (e.g. Matlab, Mathcad, RapidMiner, Origin, STATISTICA, SPSS) created by the author.
- The collected data are processed to show their distribution based on different sections, grouped and presented in graphs with their numeral characteristics.

Credibility of findings is verified by testing the research methods proposed by the author on different research scopes or experimental data sets, later periods of prognosis.

Using the results of the processed data analysis *in the result analysis, interpretation and summary part* the author has to:
- identify the main problems or groups of attributes of collected data for a more detailed research;
- confirm or deny, test hypotheses based on newly discovered data connections and attributes;
- formulate and verify conclusions on the suitability of the theoretical solution proposed in the second part of the thesis, the limits of its application, the improvement or decrease of selected indicators by applying the proposed methods of experimental research.

Conclusions and recommendations. The main **results, achieved when reaching the aim of the thesis and carrying out the tasks** are clearly presented in this part of the thesis. The conclusions stem from the research findings. Conclusions must not contain new information, which has not been introduced in former parts of the thesis, as well as rules and axioms which have already been recognised in the scientific field. A common mistake is to provide not the findings, but rather a summary of the contents of thesis as the conclusions. The conclusions of a Master's thesis emphasise the following three main subjects: the work that has been carried out, the ways that the proposed solutions help to solve the researched problem of the company and the aspects that differentiate this solution from the existing ones.

The research findings provided in the conclusions are supported by the changes in the values of the criteria selected for the assessment of systems, conducted calculations and research, providing the accuracy of criteria values that were improved in the thesis as well as the values of reliability indicators which

validate that the proposed software solution completely or partially solves the drawbacks of the researched field identified in the analytical chapter.

Examples of the formulaic expressions used for concluding statements:

- *The thesis summarises…. findings, on the basis of which, …. is solved.*
- *It was presented that … the proposed methodology… The methodology is based on…*
- *The proposed method… used to identify the features is based on…*
- *The proposed algorithm, which is tested by the experimental data…*
- *The essence of the functionality of proposed model…*
- *The assessed… indicators, the change in the values of assessment criteria… per cent.*

The recommendations are to be specific, formal, and concise. They must rise from the material presented in the first part of the thesis. The recommendations ought to have a theoretical and empirical basis. The conclusions and recommendations are provided separately.

The order of conclusions and recommendations may not reflect the order of the text. The statements are grouped and arranged in order to highlight the most important research findings. Conclusions and recommendations are to be numbered.

Final pages. Final pages consist of a list of references, appendices and their list, the created software code and a description in a computer storage media, A5 format envelope for the reviews of scientific advisor and reviewer.

Literature. When writing an MA thesis, the student uses (quotes, analyses, refers to) a variety of literary sources and documents. Therefore, the thesis must contain a list of references, grouped into literary and data sources:

- ***List of references***. The list of references contains only publications that are recognised as scientific. It consists of monographs, study books, articles in scientific journals, including electronic journals, scientific conference material, dissertation thesis and other publications that have been directly used when preparing the thesis and whose ideas helped the author to formulate his/her point of view.
- ***List of data sources.*** This list contains the collections of statistical data, standards and norms, catalogues, accounting and reporting documents of companies and organisations, advertisement publications, technical documents, official certificates, authentic experimental, research, observational primary data sources, articles in newspapers and other media outlets, information on the internet (excluding the electronic scientific journals) and other sources used and quoted in the thesis.

When preparing a list of data sources and a list of references, continuous numbering is used.

Bibliographic descriptions of the used sources are provided in accordance with the requirements (subchapter 3.2). The list of references may include only those sources that were referenced in the thesis. A MA student should analyse no less than 20 sources in his/her literary review.

Appendices. The created information systems or structural schemes of a software module, algorithms, calculation results, large scale tables, questionnaires used for survey, examples, extensive explanations, other additional, illustrative material is provided in the appendices. The appendices should include only the information that is analysed in the

main parts of the thesis description. If the thesis description does not contain a discussion about and a reference to the material provided in the appendices, such material should not be included in the appendices. The formatting requirements for appendices are provided in subchapter 3.4.

Review of the scientific advisor and the reviewer. A5 format envelope is glued on the inner side of the last page (hardcover), which contains the reviews of the scientific advisor and the reviewer as well as computerised storage media with the text of the final thesis description and the software implementation files.

2.2 The stages of Master's thesis preparation

Master's thesis is prepared throughout the entire period of Master's studies.

Master's thesis preparation plan (Annex 5) is to be prepared and coordinated with the scientific adviser within the first moth of the second semester. When writing the final thesis, this plan can be elaborated, amended, updated and should be submitted with the intermediate defence report of every semester.

The following stages of thesis preparation can be distinguished:
- Selection of the problem, formulating the topic, object, aim and objectives of the thesis;
- Preparation of the preliminary plan for Master's thesis (calendar plan) (Annex 5);
- Review of scientific literature and preparation of its analysis;
- The analysis of collected material and writing of the theoretical chapter;
- The preparation and testing of the preliminary research methodology applied in the analytical chapter;
- The gathering, processing and evaluation of research data and other material necessary for the experimental chapter;
- The preparation of conclusions, relevant suggestions and recommendations; the updating of the theoretical chapter based on the latest publications; the gathering of additional or new factual material and the execution of additional research, the summary of the research findings and their use in the analytical chapter;
- The final review of the introduction, summary in foreign language, the preparation of the list of references;
- The final formatting of the description of the thesis (title page, contents, list of tables and figures, text editing) and preparation for the defence (preparing a presentation).

Semester defence of Master's thesis is organised and evaluated during the examination session (course units Research Work I/II and Research Work II/II). At the end of the semester, no later than a week before the set defence date, Master's students are to submit to the Institute of Applied Informatics a Master's thesis report. The semester report is evaluated by the scientific advisor. The report is defended and evaluated during the meeting of the SP Committee board. During the defence, the Master's student orally presents his/her semester report (delivers a 3-4 minute presentation), supported by 3-4 MS PowerPoint slides, whose contents should reflect the Master's thesis tasks set for the semester.

During every semester, the following stages of the thesis are implemented and evaluated:

II semester
- The selection of preliminary Master's thesis topic.
- The preparation of preliminary plan of the thesis.
- The selection of literary sources and the review of current situation, assessing the aspects of the topic that have already been investigated and are already known, the problems that are looked into in the researched area.
- The analysis and grouping of literary sources, the review of main ideas.

Set out the object, aim and tasks of the thesis.
- The preparation of the material necessary for solving the theoretical problem of the thesis.
- A detailed analysis of the existing models, methods, algorithms, solutions.
- New models, methods, algorithms, conceptual, software or structural solutions proposed by the master student.
- A detailed description of the above-mentioned, the preparation of the preliminary solution proposed by the Master's student.
- The preparation of the slide presentation on the thesis.

When defending the report of the thesis, the Master's student should be prepared to answer the following control questions:
- What is the topic, aim and tasks of the thesis?
- What instruments (tools) did you choose to create a software solution?
- What existing software products did you analyse?
- What experiment are you planning to carry out to test your calculations?
- What data are you going to collect, what sources are you going to select, how are you going to process them?

III semester
- The preparation of experimental research methodology.
- The formation of experimental environment for the implementation of proposed models, methods, algorithms, schemes.
- The collection, processing and assessment of data and other material necessary for the experimental research.
- The conduct of experimental research.
- Preliminary assessment of the findings of experimental research.
- The planning, conduct of additional experiments.
- The drawing of preliminary conclusions.
- The preparation of the report for the third stage of the thesis, preparation of the presentation and slides.

Control questions:
- What distinguishes your model from the models that have already been implemented or proposed?
- What stages of the Master's thesis are already implemented and are the obstacles that you are facing?
- What is the expected thesis result, its essence and the form of presentation?

IV semester
- The updating of theoretical chapter based on the conducted experiments and latest literary sources.
- The collection of additional experimental material and the conduct of additional research, the summary of its findings.

- Conclusions on the practical application of research findings.
- The preparation of summarising conclusions, proposals and recommendations.
- The preparation of the introduction (final version), summary (in foreign language) and a list of references.
- Final formatting of the Master's thesis (title page, contents, list of tables and figures, text editing, etc.).
- Preparation for the public defence of the thesis, preparation of presentation and slides.

To improve Master's students' academic writing skills, VU KnF Institute of Applied Informatics recommends its students to submit and publish an article and deliver a presentation at a scholarly conference during the preparation of Master's thesis. Master's students who have published an article in a scientific journal receive additional points during the defence.

3. PREPARATION OF MASTER'S THESIS DESCRIPTION

This part explains the main requirements for thesis formatting, introduces the rules of citing and referencing; ways of providing the bibliographic description of literature, tables, figures and formulas in the text and appropriate text formatting.

3.1 Citations and references

When writing various studies and scientific works, the authors often not only present their original thoughts, but also retell the ideas of other authors. The borrowing of ideas is praiseworthy, for it demonstrates erudition of the author and the ability to use intellectual instruments. Several types of borrowing can be distinguished:

- direct quotation, when the text of another work is repeated verbatim;
- indirect quotation, when the ideas of another work are restated consistently;
- mentioning of the idea, when the already published idea is further developed, but the author articulates it using his/her own logic and consistency when tackling the chosen issue.

References are created according to the ways the ideas put forward in literary sources are used in the thesis. Every type of reference is subject to different requirements; what is more, references are determined by the style of the author. The number of references, the section there they should be presented, and their form are directly associated with an individual's ability to formulate ideas in a written form, the mastering of theoretical notions and the strategies of choosing the empirical material. References conform reading to the natural form of active thinking.

The original books and their first or latest editions are best suited for references. Various scientific and cultural events, historical dates, statistical data, graphical documents associated with the text and other unique illustrative material can also be used as references. It is essential to consider the proportions and font of the text and references, their layout in the page and visual expression.

Citing. In Latin *citatum* means *verbatim excerpt.* An excerpt with a clear, logically completed thought must be chosen when quoting. Most frequent mistakes when quoting (Misevičius, 1995, p. 97):

1.   Non-selective quoting. Quoting of the outdated or non-authoritative source, which does not solve the problem, but only puts it forward and in which the analysed question takes up a very small part.

2.   Unfair quoting. The forced use and distortion of quoting and the discontinuation of thoughts or phrases in order to assign a different, desired meaning.

3.   Excessive quoting. Excessive quoting gives the impression that the author cannot refer to and briefly, in his own words retell the thoughts of another author.

4.   Plagiarism (lat. Plagium – abduction). It is the appropriation of authorship and taking the credit for the works, inventions, ideas and thoughts of other authors. It is a very lamentable act equivalent to theft. The absence of reference to the literary source and the failure to indicate the authorship of someone else's thoughts and ideas (verbatim or retold) used in the theses is recognised as plagiarism.

Provision of the quotations:

1.   the quotation is preceded by the colon; the quotation is provided in quotation marks and starts with a capital letter.

2.   long quotations are provided in a new line;

3.   quotations that form a part of the author's sentence are provided in quotation marks and start with a lower case letter.

4.   omitted parts in the quotation are marked with ellipsis in the brackets <…>, (…).

The exact source of the quotation must also be provided. The main methods of providing bibliographical data:

1. in the text;

2. in a footnote;

3. at the end of the thesis;

4. in an explanatory note (in an auxiliary text)

Usually, the references are provided in the text. Brackets are used to indicate the source which provides almost all essential elements: the author, year of publication, page number. For example:

(Surname, First Initial., 1999, p. 135)

If several publications of the same author published in the same year are quoted, next to the year of publication in both the list of references and the reference lower case letters in alphabetic order are written. For example:

In the reference it is written as follows: (Surname, N., (2002b), p. 59)
List of references:
SURNAME, NAME. (2002a) *Statistika.* Vilnius: Aldorija. 690 p. ISBN 9986-820-24-3.
SURNAME, NAME. (2002b) *Informatika.* Kaunas: Naujasis lankas. 240 p. ISBN 9955-03-149-2.

Foreign publications are provided in the original language. The Cyrillic script publications may be written using Latin script in the Lithuanian text; in the page footnote the authentic script should be used.

Often quoted original author's and other works are provided in the page footnote. In the footnote, their descriptions may be shorter than in the list of references; however,

the author, the title, the publishing place and the page number must be provided. For example:

> [1] SURNAME, First Initial. (2000) *Statistika.* Vilnius, p. 36.
> In the text it is written as follows: The concept of statistical elements was analysed by N. Surname[1].

In a repeated reference only the author's surname, main heading and page numbers are provided. If the heading is long, it is allowed to write only three words and put ellipsis. Often repeated reference is interchangeable with words: tas pats, to paties, ten pat (for Lithuanian publications), ibid, odem (for Latin script publications), его же, там же (for Cyrillic script publications).

If the quotation is not copied from a primary source but instead from another publication which used the quotation, the reference must begin with the words cit. pagal.:… (for Lithuanian publication), op. cit.:… (for foreign publication). For example:

> SURNAME, First Initial. (2000) *Statistika.* Vilnius, 36 p. – op. cit.: SURNAME, First Initial. *Ekonometrija.* Kaunas, 1998, p. 54.

References to the periodicals and continuous publications are usually provided at the end of the thesis.

Explanatory notes are provided in page footnotes or at the end of the text. They are explanations of the terms and concepts; they often provide excerpts of definitions and statements along with bibliographical data of the sources.

Retelling. In this case the quotation requirements are not imposed. However, when the idea is retold, a bibliographical reference to the source of the idea must be provided. References, just like in the case of quotation, may be provided in the text, page footnote, at the end of the work or in an explanatory note. The reference is inserted in the paragraph at the exact place where the retold idea is ended. If the reference spans the whole paragraph, it is inserted at the end of the paragraph. If the same idea is retold in several paragraphs, at the end of each one a separate reference must be provided. The author and the year must be provided when the reference is inserted in the text. The pages are provided when the author's idea is retold concisely (for example, as a definition); if the text is retold freely, the pages may be omitted.

If the author retells the ideas not from the primary source, the original author and the secondary source must be provided. In this case, the bibliographical reference "op. cit." is used. A simpler option is to mention the original author in the text and make a reference to the source that the quoted author directly used. It is strictly *prohibited* to make a reference only to the primary source if the thesis author is not directly familiar with it.

Mentioning of the ideas. It is the least restricted use of someone's expertise when writing a thesis or a scientific work. In this case no intentions are made to use someone's interpretation logic; only the final results of the analysis: terms, concepts and ideas. The scientific ethics state that other authors should be referenced when their ideas are borrowed. That is not always easy to do, for the most popular ideas quickly lose the authorship identity and become "generic". Therefore, theses include many ideas with untraceable authorship. However, theses and study works usually aim at analysing not old but brand new ideas. All brand new ideas have authorship. In this case, the authorship must be provided.

Provision without specific reference in the body text. If you did not analyse any source of the mentioned author, but know that he/she has promoted this idea, you may only mention him as the author.

First Initial. Surname distinguished three types of competitive strategy

Provision with literary source reference in the text. The year of source publication is provided in the body text, written in brackets next to the mentioned surname. That source must be included in the list of sources used in your work. You must be familiar with that source.

…N. Surname (2011) distinguished three types of competitive strategy…
List of references:
SURNAME, NAME. (2011) *Competitive Strategy: Techniques for Analyzing Industries and Competitors.* New York: The Free Press. 200 p. ISBN 4563-25-456-7.

When writing **theses**, references to scientific sources are provided in the text (the author, year, page number); references to the informational sources are written as a shorter description of the literary source and provided at the end of the page in a footnote.

3.2 Bibliographic description of literature

When writing the Master's thesis, printed and internet sources, documents, calculations and statements may be quoted or mentioned in the text. All literature quoted and used in the work along with other sources must be appropriately described and provided in a separate chapter called "List of References". The chapter must follow the applicable rules of bibliographic description of the document. The list is written in alphabetic order.

Requirements for the descriptions of books and dissertations

Examples:
1.　　SURNAME, NAME. (1998) *Statistika.* Vilnius: Margi raštai. 226 p. ISBN 9986–09–183–7.
2.　　SURNAME, NAME. (2009) *Modern human relations at work.* 7th ed. Fort Worth: The Dryden Press, 449 p. ISBN 0-03-022374-1.
3.　　SURNAME, NAME. (2014) *Darbuotojų santykių transformacija informacinių technologijų taikymo poveikyje.* Nepublikuota mokslų daktaro disertacija. Kaunas. 193 p.
If the book does not have an author:
1.　　Pagrindiniai reklamos teisės aktai. (2017) Teisės aktų, paskelbtų iki 2001 m. sausio 31 d. rinkinys. Vilnius: Teisės informacija. 129 p. ISBN 9955-458-01-1.

· **Requirements for the descriptions of articles, laws and conference presentations**

Examples:
An article in a journal:
1. SURNAME, NAME. (2013) Žmogiškasis kapitalas. *Inžinerinė ekonomika*, rugsėjis, p. 20 – 25.
2. SURNAME, NAME.; SURNAME, NAME. (2008) Emotional aspects of large group teaching. *Human Relations*, December, vol. 51, no. 11, p. 1403 – 1456.
An article in the book:
1. SURNAME, NAME. (2012) Управление переменами. *Информационные технологии в бизнесе.* Санкт - Петербург: Питер. p. 476–480. ISBN 5-318-00125-4.

An article in the conference material:
1. SURNAME, NAME; SURNAME, NAME; SURNAME, NAME. (2015) Extracting rules from trained RBF neural networks. *Environment. Technology. Resources.* Proceedings of the 5th international scientific and practical conference, June 16-18. Rezekne: Rezekne higher education institution, p. 20 – 28. ISBN 9984-766-05-5.

The elements of description of electronic documents and the procedure for their submission

- Electronic monographs, databases and computer programs

Examples:
1. NAME, SURNAME. (2016) *Švietimo vadyba ir kaita. Summary of a monograph submitted for habilitation* [interactive]. Vilnius: Vilniaus pedagoginis universitetas, [accessed on 29 November 2016]. Available from: <http://www.vpu/lt/bibl/elvpu/003/Pavardenis.pdf>.
2. *Meeting agenda* [interactive]. (1991) Gif-sur-Yvette (France): Center d'Etudes nucleaires/Saclay. Service de Documentation, March 1991 [accessed on 30 September 2017.]. Updated every two months. ASCII format. Available from: QUESTEL.
3. *Lithuania and European Union: Information Office of the Council of Europe* [interactive database]. (2015) Seimas of the Republic of Lithuania: Office of the Seimas of the Republic of Lithuania [accessed on 15 September 2017.]. Available from:
   <*http://www3.lrs.lt/pls/inter/w3_viewer.ViewTheme?p_int_tv_id=1027&p_kalb_id=1*>.
4. *List of international publications included in the databases of the Institute of Scientific Information* [interactive database]. (2016) Department of Science and Higher Education: Mokslas.lt. Updated on 3 June 2016 [accessed on 23 October 2017 m.]. Available from: <http://www.mokslas.lt/mokslas/naujienos.htm>.

- Articles and other sources

Examples:
1. STONE, Nan. (2015) The Globalization of Europe. From *Harvard Business Review* [interactive]. May – June [accessed on 2 September 2017]. Available from: BRS Information Technologies. McLean (Va.).
2. PRICE – WILKIN, John. (1994) Using the World – Wide Web to deliver Complex Electronic Documents: Implications for Libraries. From *The Public – Access Computer Systems Review* [interactive], vol. 5, no. 3 [accessed on 28 July 2017], p. 5 – 21. Available from: <gopher://info.lib.uh.edu:70/00/articles/e-journals/> ISSN 1048 – 6542.
3. SURNAME, NAME. (2016) Ar brangi reklama internete? [interactive]. *Ebiz.lt*, 22 August [accessed on 10 November 2017]. Available from: <http://www.ebiz.lt/article.php3/19/1331/6>.
4. ELTA. (2017) Pristatyta Elektroninių ryšių įstatymo koncepcija [interactive]. *Politika.lt*, 28 October [accessed on 28 August 2017]. Available from: <http://www.politika.lt/news/verslas/,43046>.

3.3 Tables, figures, formulas and appendices

Tables and figures may be inserted in both text and appendices. All tables, figures and appendices must be numbered and titled. Tables, figures and appendices are numbered separately. Numeration proceeds as follows: Table 1, Fig. 1, APPENDIX 1.

The number of the table (e.g. "Table 1") is written in the corner above the title of the table. It starts with a first capital letter and is proceeded by lower case letters; the title is placed above the heading of the table in the centre of the page, the font is bold, 12 pt. If the text contains only one table, only the word "Table" is written above the table in the right corner of the page. Font size of the presented information in tables is 10 pt. It is necessary to indicate the source of the table, this also applies if the table is created by the authors themselves (Annex 6).

The number of the figure (e.g. Fig. 1) and the title are to be written below the figure in the centre of the page, the font being bold, 12 pt. The font size in figures is 10 pt. The source of the figure is indicated below the title of the figure, this also applies if the material is created by the authors themselves (Annex 7).

Tables and figures can span a part of the page, one, two or more pages. However, a table or any other visual material are not to be divided into two pages if they fit into one page.

If a table span more than one page, it is specified so in the right corner of the continued table, e.g. "Table 1 (continued)". The titles of the columns are written once again and the table is continued to be filled.

If it is foreseen that the table would take up almost the whole page or the bigger part of it, it is advisable to start the table not immediately after the text but in a new page.

Tables of larger scale with a considerable amount of information and extensive illustrations should be presented in appendices.

Examples of the tables and figures are in the appendixes 7 and 8.

Formulas in the text are written following the rules of punctuation; they are placed in the middle of the line while the words linking them (*because*, *here*, etc.) are to be written in the next line. Additional lines should be left before and after the formulas in order to make formulas distinct from the rest of the text (Kardelis, 2002, p. 355).

Symbols are to be explained below the formula respectively as they appear in the formula. Below the formula there should be a comma and a word *here* (with no colon) should appear in the next line. Thus, all symbols present in the formula are to be indicated and followed by a dash and the explanation of their meaning. An example of a formula (Kardelis, 2002, p. 355):

$$S_x = \frac{S}{\sqrt{n-1}} , \tag{1}$$

here S_x – tolerance of the arithmetic average;

S – standard deviation;

n – sample capacity.

Figures, tables and formulas are numbered following a continuous numbering system.

3.4 Text requirements

The text should be written on one side of blank non-linear A4 paper.

Text of the Master's thesis should be:
- clear;
- written in fluent and correct language with no grammatical, stylistic or proofreading errors;
- printed in high quality;
- in accordance with all necessary requirements for such type of work.

Page parameters for text printing:
- top margin – 20 mm;
- bottom margin – 20 mm;
- left margin – 25 mm;
- right margin – 15 mm.

Text requirements:
- paragraph begins with a 1.27 cm indent;
- text font – Times New Roman;
- font size – 12 pt;
- line spacing – 1.5;
- text alignment – justified.

Page numeration:
- page numeration begins with the table of contents (page counting starts from the title page) and ends with the last page of the thesis;
- the number of the page should not appear on the title page;
- the number of the page should be written in the right corner at the bottom of the page;
- number of the page should be written in Arabic numerals with no dots nor dashes;
- it is not allowed to skip any pages, repeat the same numbers or add any letter symbols.

The text of the empirical research part is to be divided into chapters, subchapters and, if needed, into paragraphs.

Requirements for chapters and subchapters:
- chapters are numbered in Arabic numerals (1., 2., etc.);
- chapters: contents, list of figures, list of tables, list of abbreviations, summary, introduction, conclusions and solutions, references and appendices are not numbered;
- the number of chapters and subchapters depends on the topic of the thesis, however, chapters/subchapters should not be too narrow (usually a chapter consists of 2–5 subchapters. The extent of the smallest constitutional unit should no be less than 1–1.5 pp.).
- subchapters are numbered within chapters and their number constitutes of two Arabic numerals (1.1., 1.2., …. 2.1., 2.2., etc.), which are separated by dots from one another and from the title of the subsection;
- chapters are provided in a new page, the titles are bold ,14 pt, written in capital letters and centred;
- titles of subchapters are written in lowercase letters (except for the first letter in the heading which should be capital), the alignment is left, 12 pt, bold;
- titles of subchapters are separated by one line before and after the title;

- subchapters are positioned consistently in the same page;
- if the text is also divided into paragraphs, they are written using the same principles as those used with subchapters; the number of the paragraph comprises of three numbers separated by dots (1.1.1., 1.1.2., etc.);
- the title of the subchapter should not be written right after the title of the chapter, an introductory paragraph should be inserted between the two.

Contents of the Master's Thesis:
- contents should include all numbers of chapters and subchapters that are present in the thesis, also their titles and numbers of pages where the chapters/subchapters begin;
- the word "CONTENTS" and the titles of chapters are written in capital letters while the titles of subchapters are written in lowercase letters (except for the first letter which is capital).

Appendices of the Master's Thesis:
- every appendix should begin in a new page and the title "APPENDIX" (capital letters, 12 pt) should be placed in top corner of the page;
- the title of the appendix is written in bold and capital letters;
- if there appears to be more than one appendix, they are to be numbered accordingly: APPEDIX 1, APPENDIX 2, etc.;
- if there are less than 5 appendices, they are to be written in CONTENTS indicating their page number;
- if there are more than 5 appendices, there should be a separate list of appendixes called "APPENDICES" where the titles of appendixes and their page numbers are indicated. The list should be inserted at the end of the thesis before the appendices; the page number of the list of appendices should be indicated in CONTENTS;
- the text must contain references to appendices.

4. DEFENCE AND ASSESMENT OF MASTER'S THESIS

The thesis is assessed during public defence. However, it is important to note that the preparation for the defence of the Master's thesis and its assessment is performed in several stages which must be executed before public defence. These stages must be carried out without violating the time frame provided by the Institute of Applied Informatics.

First of all, the quality of the paper and its eligibility for defence are assessed by the scientific adviser of the Master's thesis. The written paper is presented to the scientific adviser of the Master's thesis, who then determines whether the paper fits the requirements posed for a Master's thesis. If the quality of the paper is sufficient, the scientific adviser puts a signature on its first page.

University rector or his commissioned vice-rector approves the composition of the scientific board on the offer of Dean of the Faculty, sets the dates for the defence in the Study Programme Committee (SPC) and public defence. During the defence in the Study Programme Committee (SPC) the author of the Master's thesis presents the complete paper (unbound), and prepares the presentation of the paper. Members of the scientific board assess whether the thesis is suitable for public defence, and provide comments on how the thesis could improved until public defence.

Up to one week before the set date of the defence of the Master's thesis the papers are submitted to the Institute of Applied Informatics (two printed and bound copies, one of which is hardcover, along with digital storage devices containing files). Additionally, no longer than five days before the defence date the paper must be uploaded to the information system of the university. Then the paper is registered, and its reception date is indicated.

The Institute of Applied Informatics provides one copy to the reviewer who is appointed by the chairman of the Study Programme Committee (SPC). The reviewer critically examines the paper and writes a review in which he/she discusses novelty, relevance, positive sides and drawbacks of the thesis, provides a conclusion whether the paper fits the requirements posed for Master's thesis, and proposes evaluation. The Institute is supplied with the review no later than one day before public defence. The Master's student has the right to familiarise himself/herself with the review until the day of defence in order to prepare for answering the questions which are indicated in it.

The authorship of all Master's theses must be confirmed. For this purpose, the Master's student must fill in, print and provide the Institute with the signed authorship guarantee text which could be accessed via VU database, to enter the details about the final paper and its summary in VU graduation paper database. All versions of thesis are verified by plagiarism detection software. The data about authorship and plagiarism check results are provided to the scientific board.

The final paper assessment is provided by the scientific board after public defence of the Master's thesis. The composition of the scientific board and its chairman are approved by the rector on the proposal of the Institute and after approval of the Dean of the Faculty. Defence is not allowed if the scientific adviser decides that the paper is improperly prepared or prepared without the participation of the scientific adviser of the Master's thesis. In this case the student has the right to contact the scientific board with a request to defend the thesis.

The preparation of thesis presentation (report)

The amount of time for the presentation of the final paper is 6–8 minutes. The content of the presentation should consist of the elements provided in Table 2. The presentation is delivered orally while showing slides. The slides must reflect all parts of the Master's thesis, the essential results obtained by the Master's students, schemes, screenshots illustrating the algorithm or prototype operation of the software product created by the student are provided.

15-20 slides are recommended for the presentation

Table 2

The structure of Master's thesis presentation

MASTER'S THESIS
• The title slide (university title, thesis title, author's name, surname, group, e-mail, scientific degree, name and surname of the scientific adviser)
• The scientific problem which is researched, its relevance
• The object, aim and objectives of the thesis, research methods
• The scientific basis of the Master's thesis (theories, standards, methods, and similar systems)
• The results of the theoretical-analytical parts of the thesis

The Procedure for Master's Thesis Preparation. Methodological Guidelines

Table 2 (Continued)

• The essence of the proposed solution, main features, differences and similarities compared to already existing solutions
• The results of the experimental research or a developed prototype are illustrated by screenshots
• Conclusions and recommendations
• The description of an article written and published by the Master's student (if any)

Source: created by the authors.

Slides are prepared using generally accepted style, e.g., border, headline fonts and sizes. All slides, excluding the first (title slide) must be numbered, indicate the name of the university which is represented and the name, and surname of the author (Figure 2). The slides must be prepared qualitatively: more than 8 to 10 lines of text per slide are not recommended, large-scale schemes must be prepared in such a way that they could be fully readable, the background of the slides and the colours of the letters should have sufficient contrast.

Source: created by the authors.

Fig. 2. An example of a slide.

In order to avoid unexpected inconveniences during the thesis defence, it is recommended to prepare the presentation in advance and read it out loud for one's colleague. If there is a possibility to record one's rehearsal of the presentation, it is

recommended to do so because it is very useful to watch it later and evaluate it critically in order to make improvements.

During the presentation excessive reading should be avoided. The scientific board is more likely to be convinced when a person talks clearly and freely about their presentation emphasising the key points of it. While answering the questions of the scientific board and the remarks of the reviewer, the Master's student may use his/her work and quote it. The answers should be specific and brief.

At the end of the defence the student may respond to the remarks of the scientific board if any were stated; the student can also tell more about his/her further research plans and thank everyone who helped to prepare the thesis.

The procedure of the Master's thesis defence

The defence of Master's thesis is public, i.e. anyone willing to participate in the defence (to be in the room where the defence takes place, to propose questions for the graduate, to participate in discussions and review the work) are allowed to come.

The defence takes place in the following order:
1.   The chairman of the scientific board calls the author of the work, announces the theme of the work, name of the academic supervisor and invites the author to speak.
2.   The author presents his/her work in 6–8 min.
3.   The floor is given to the reviewer. If the reviewer is not present in the defence, the chairman or a member of the scientific board introduces the review.
4.   The student responds to remarks and questions (if any).
5.   The speaker is given the questions which he/she has to answer impromptu without any additional preparation.
6.   Other members of the scientific or or participants of the defence may give their remarks; other reviews are read (if any).
7.   The scientific adviser is given the floor.

After the scientific board has heard all the presentations, a closed session is held where the scientific board evaluates papers according to the evaluation criteria. After the session the chairman of the scientific board announces final evaluation of the papers which will be indicated in the Master's Diploma Supplement.

__We wish you all luck!__

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ANNEXES

ANNEX 1 An example of the first page of the Master's thesis

ANNEX 1 (CONTINUED) An example of the second page of the Master's thesis

ANNEX 2 An example of the content structure

ANNEX 3 Examples of list abbreviations, tables, and figures

ANNEX 4 An example of a summary

ANNEX 5 Master's thesis preparation form

ANNEX 6 Tables

ANNEX 7 Figures

ANNEX 1

An example of the first title page of Master's thesis

VILNIUS UNIVERSITY
KAUNAS FACULTY

Institute of Applied Informatics

Business Informatics
State Code 62109P101

NAME SURNAME

MA THESIS

THE APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN STOCK PRICE FORECASTING

Kaunas 2017

The Procedure for Master's Thesis Preparation. Methodological Guidelines

ANNEX 1 (CONTINUED)

An example of the second title page of the Master's thesis

VILNIUS UNIVERSITY
KAUNAS FACULTY

INSTITUTE OF APPLIED INFORMATICS

NAME SURNAME

MA THESIS

THE APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN STOCK PRICE FORECASTING

Defendable

Graduate student_____

(signature)

Scientific adviser_____

(signature)

(scientific degree, academic title, name and
surname of the scientific adviser)

Handing-in date

Registration No.

Kaunas 2017

An example of the content structure

CONTENTS

LIST OF ABBREVIATIONS
LIST OF FIGURES
LIST OF TABLES
SUMMARY
INTRODUCTION
1. CHAPTER TITLE (in capitals)
    1.1. (subchapter title)
      1.1.1. (paragraph title)
      1.1.2
    1.2. (subchapter title)
      1.2.1 (paragraph title)
2. CHAPTER TITLE (in capitals)
    2.1.
      2.1.1
      2.1.2
    2.2.
    2.3.
3 CHAPTER TITLE (in capitals)
    3.1
      3.1.1 etc.
CONCLUSIONS AND RECOMMENDATIONS
REFERENCES
APPENDICES

ANNEX 3

Examples of list of abbreviations, tables, and figures

LIST OF ABBREVIATIONS

IT – information technologies
IS – information systems

LIST OF TABLES

LIST OF FIGURES

ANNEX 4

An example of a summary

LAST NAME, First Initial. (2017) *Research of open source-based advanced models for e-business solutions.* MBA Graduation Paper. Kaunas: Vilnius University, Kaunas Faculty, Department of Applied Informatics. 75 p.

SUMMARY

Text

ANNEX 5

Master's thesis preparation form

VILNIUS UNIVERSITY
KAUNAS FACULTY
INSTITUTE OF APPLIED INFORMATICS

BUSINESS INFORMATICS MASTER'S DEGREE PROGRAMME
RESEARCH WORK PLAN

Graduate student   Tel.
                    (name, surname)
Duration of Master's studies from 20….. till 20…...
TOPIC

Scientific adviser
                    (name, surname, scientific degree, academic title, workplace, phone No.)

Thesis annotation:

Aim:

Objectives:

Methods to be analysed and used in the thesis

Expected findings

Research work plan

Semester	(Date)	Tasks
S2		
S3		
S4		

Graduate student   Scientific adviser
                (signature)   (signature)

ANNEX 6

<u>Tables</u>

Table formatting:

Table N

\<Table title\>

\<Column title\>	\<Column title\>

Source:

1. Table in one page

● *If the table is copied from a literary source, it is formatted as follows:*

EXAMPLE

Table1

Company requirements for IS

Title	Function title	Function	Additional information
Order accounting	Registration and correction of customer data	Registration of customers who place orders, possible correction, review, search and removal of customer data.	Customers are the ones who place orders for cargo transportation.

Source: LAST NAME, First Initial. (1999) *Requirements for IS*, p. 11.

● *If the table is created by the author, it is formatted as follows:*

EXAMPLE

Table 1

Company requirements for IS

Title	Function title	Function	Additional information
Order accounting	Registration and correction of customer data	Registration of customers who place orders, possible correction, review, search and removal of customer data.	Customers are the ones who place orders for cargo transportation.

Source: created by the author.

● *If the table is created based on a literary source, it is formatted as follows:*

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Source: created by the author based on LAST NAME, First Initial. (1999) *Requirements for IS*, p. 11.

ANNEX 6

2. The table is split across several pages.

EXAMPLE. *On **page 1** the table is formatted as follows:*

Table 1

Company requirements for IS

Title	Function title	Function	Additional information
Order accounting	Registration and correction of customer data	Registration of customers who place orders, possible correction, review, search and removal of customer data.	Customers are the ones who place orders for cargo transportation.

Source: created by the author based on LAST NAME, First Initial. (1999) *Requirements for IS*, p. 11.

*On **page 2** the table is formatted as follows:*

Table 1 (continued)

Title	Function title	Function	Additional information
	Registration and correction of customer data	Registration of customers who place orders, possible correction, review, search and removal of customer data.	

Source: LAST NAME, First Initial. (1999) *Requirements for IS*, p. 11.
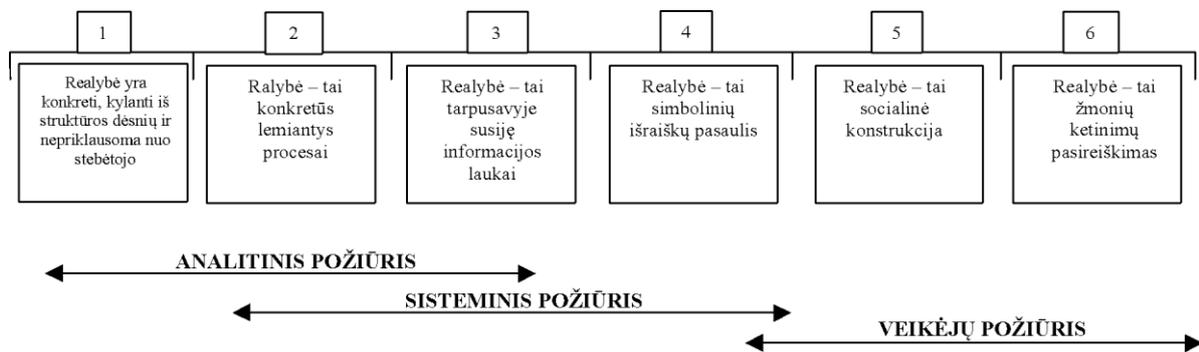
Figures

Formatting of figures:

Source:

Fig. N. Figure title.

● *If the figure is copied from scientific literature or other sources, it is formatted as follows:*
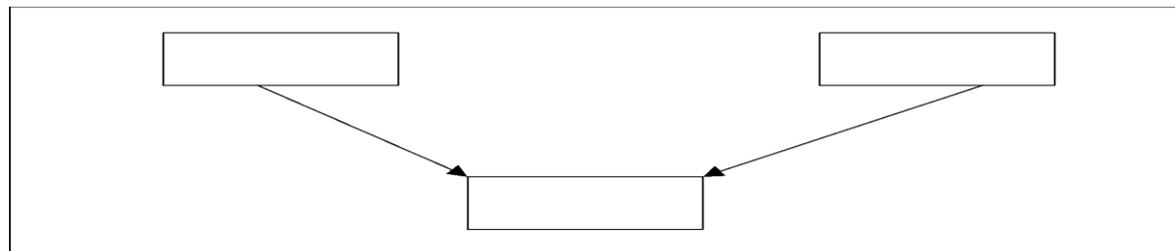**EXAMPLE**

Source: ARBNOR, I.; BJERKE, B. (2014) *Methodology for Creating Business Knowledge*, p. 30.

Fig 1. Methodology and paradigmatic position.

●*If the figure is created by the author, it is formatted as follows:*
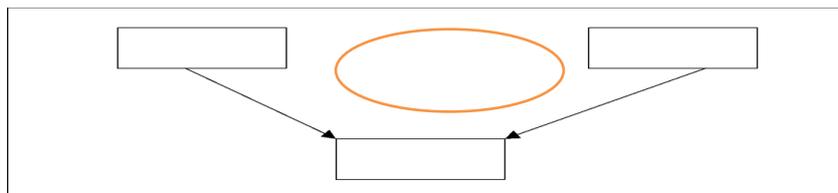
EXAMPLE

Source: created by the author.

Fig. 1. Object merging into one object.

●*If the figure is created based on a literary source and modified by the author, it is formatted as follows:*
EXAMPLE

Source: created by the author based on ARBNOR, I.; BJERKE, B. (2014) *Methodology for Creating Business Knowledge*, p. 30.

Fig. 1. System structure.