MASTER'S THESIS

Developing an executable Model of a Protocol for a Systematic Review

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Abstract

A systematic review is a research method dedicated to collecting and synthesizing available sources to produce new knowledge, which may highly support evidence-based decision making. The process of a systematic review can be modelled to serve as a guide for the researchers. The systematic review process consists of a planning, conducting and reporting stage, that each contain several steps. This work intends to model a guide to be used by researchers conducting a systematic review. The full process is captured in a goal refinement tree and the elements of the goal refinement tree are used as input for the design of a protocol model. Use cases of the protocol model are presented, based on analyses of abstractions that can be used to design a support system for conducting systematic reviews.

Key terms

Systematic Review, Executable Modelling, Protocol Modelling, Protocol

Abbreviations

ExtREME	Executable Requirements Management and Evolution
IMS	Interactive Modelling and Simulation
KAOS	Keep All Objectives Satisfied
UML	Unified Modelling Language

Contents

1. Introduction

1.1. Background

In the rapidly changing business environment, organizations need to stay competitive. One of the factors to determine organizational success and to stay ahead of the competition is an organization's ability to effectively acquire and manage its knowledge.

The methodological completeness of systematic reviews made it the reference standard for synthesizing research studies, especially in health care. In 2010, an estimated number of 11 reviews were published on a daily basis (Moher, et al., 2015).

In contrast with the widespread use of systematic reviews in the field of health care, systematic reviews are rarely conducted in management and organizational studies (Briner & Denyer, 2012). Briner & Denyer (2012), therefore, argue whether research in those studies is sufficiently contributing to evidence-based management (EBMgt). According to Briner, Denyer, & Rousseau (2009), the idea of EBMgt is obstructed by misconceptions which is partly due to misunderstandings in terms of the way to conduct and use systematic reviews. Clarifying those misunderstandings should help to show the potential advantages of systematic review studies. The accumulation of available knowledge constructs a reliable knowledge base for practitioners and managers (Tranfield, Denyer, & Smart, 2003) and may be used to synthesize existing evidence in order to produce new knowledge, identify gaps to suggest topics for further exploration and/or provide frameworks to position new research projects.

Several checklists and sets of guidelines can be found in literature. However, they are often specific to a certain domain or they only provide generic guidelines or requirements and fail to provide precise steps to complete a systematic review. The variety of research topics and the results of findings that steer the research during its execution, are assumed to be the main challenges to create clear guidelines. The core of a systematic review, however, is independent of the research domain. Therefore, this paper will evaluate the minimum set of steps to complete a systematic review and the possibility to create an adaptive support system to facilitate the execution of a systematic review in all research domains.

1.2. Exploration of the topic

A systematic review is a comprehensive and strongly evidence-based research method that is widely used in both academic and professional environments (Briner & Denyer, 2012). The steps of the research method are chosen deliberately and recorded explicitly for the purpose of excluding arbitrariness.

A systematic review may be considered as a process in which:

1. review question(s) are formulated;
2. a comprehensive list of potentially relevant research studies is generated;
3. research studies are selected based on explicit inclusion and exclusion criteria;
4. selected studies are analysed and synthesised and;
5. the final results are reported (Saunders, Lewis, & Thornhill, 2016).

The steps that define the core of the systematic review are assumed to be shared between all research domains. Additional steps may be added depending on the research area. In order to create clear guidelines, the steps may be mapped out in a support system. Several modelling techniques may contribute to the development of a support system. Goal modelling aims to describe a system in terms of its objectives. Whereas behavioural modelling maps the functioning of a system in terms of its states and transitions. The Executable Requirements Engineering Management and Evolution (ExtREME) methodology is a modelling technique that allows for quick understanding, implementation, simulation, and testing of new requirements on the model (Roubtsova, 2016). The methodology supports users to interact with the system by submitting events and observing states, as well as by interpreting model parts in terms of goals and requirements; combining the semantic features of goal modelling and behavioural modelling. The idea of the methodology is to create a constant cycle of executing and developing the model. Due to the adaptive nature of the methodology, it may be a suitable solution to the challenges presented before.

1.3. Research Problem

Conducting a systematic review demands following a strict protocol. Researchers find it difficult to follow the protocol and, in some cases, skip steps. This causes unrepeatable literature searches, unreliable research results and, sometimes, inconsistency between research questions and research results. A support system with clear guidelines to complete a systematic review is needed. The first steps to such a system are the design of a goal and a protocol model.

1.4. Research Questions

This research study aims to develop an executable model of a protocol in order to execute a systematic review. This objective resulted in the following main research question:

What is the protocol and what are the abstractions of a support system executing the protocol of a systematic review?

The main research question was further divided into the following sub-research questions:

RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?

The aim of this question is to investigate what guidelines to conduct a systematic review can be found in the existing literature. In order to evaluate how those methods are used in practice, a case study was performed by the authors and presented in this paper. The results serve as guiding principles of the needed properties of an executable protocol.

RQ 2: How can the requirements of a support system, following the proposed approaches, be identified and modelled?

After finding the proposed guidelines, the aim of this question is to determine how the requirements of a system can be elicited and to what extent it will be possible to develop an executable protocol.

2. Theoretical framework

2.1. Research approach

In order to have an overview of the existing knowledge around the research topic, the investigation started with a review of the literature. The aim of the literature review was to answer the sub-research questions as identified in the introduction. Following the gathering of available knowledge regarding sub-research question 1, a case study was executed to evaluate the extent to which the theory is used in practise and to understand the gaps to be covered by the potential model, which was developed as a result of the research.

2.2. Results and conclusions

RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?

As the name of the methodology suggests, there is a clear desire to follow a predefined approach to undertake a systematic review. Besides ensuring comprehensiveness, following a predefined approach reduces the chance of bias and error. The approach should include a rigorous search for primary studies, the selection of studies based on clear and reproducible eligibility criteria, critical quality review of primary studies and synthesis of results according to a predetermined and explicit method (Akobeng, 2005; Saunders, Lewis, & Thornhill, 2016).

Although, systematic reviews are the most evidence-based type of studies, it should not be expected that all systematic reviews are valid. Akobeng (2005) specifically emphasizes the importance of inclusion and review of all potentially relevant materials and provides a list of ten questions that may be considered when appraising a systematic review;

- *Did the review address a clearly focused question?*
- *Did the review include the right type of study?*
- *Did the reviewers try to identify all relevant studies?*
- *Did the reviewers assess the quality of all the studies included?*
- *If the results of the study have been combined, was it reasonable to do so?*
- *How are the results presented and what are the main results?*
- *How precise are the results?*
- *Can the results be applied to your local population?*
- *Were all important outcomes considered?*
- *Should practice or policy change as a result of the evidence contained in this review?*

In line with the widespread use of systematic reviews in medical science, extensive guidelines are available on how to conduct them (Briner & Denyer, 2012). The PRISMA checklist offers an overview of a minimum set of items for reporting in systematic reviews (PRISMA, 2019). It is not an outline of a step-by-step approach but it does give a clear and structured overview of the items that should be included, as well as the extent to which they should be described. Reviews utilizing the PRISMA checklist show a significant quality increase compared to reviews that did not utilize the checklist (Panic, Leoncini, De Belvis, Ricciardi, & Boccia, 2013).

Another checklist was designed by the Critical Appraisal Skills Programme (CASP). This checklist consists of ten questions to help assess the quality of a systematic review but may also be used to review one’s own work (Critical Appraisal Skills Programme, 2019).

It may be argued whether the checklists offer sufficient guidelines to develop a protocol for a systematic review. The lack of protocols causes waste in research. An estimated eighty-five percent of investments made in research are lost due to inappropriate design and methods and biased, incomplete or unpublished reports (Chalmers & Glasziou, 2009).

In a first attempt to provide clearer guidelines for the conduction of systematic reviews in the field of management research, Tranfield, Denyer, & Smart (2003) compared the medical and management fields and highlighted the differences. Based on The Cochrane Collaboration's *Cochrane Reviewers' Handbook* by Clarke & Oxman (2001) and the National Health Service Dissemination (2001), they provided a list of stages and phases in conducting a systematic review in medical science (Fig. 2.1) and identified the main characteristics of the approach. The approach clearly identifies three stages; (1) planning the review, (2) conducting the review and (3) reporting and dissemination. For each stage, they emphasized the key challenges in adopting a similar approach in management research and provided recommendations on how to address them.

Stage I–Planning the review

Phase 0 - Identification for the need for a review
Phase 1 - Preparation of a proposal for a review
Phase 2 - Development of a review protocol

Stage II–Conducting a review

Phase 3 - Identification of research
Phase 4 - Selection of studies
Phase 5 - Study quality assessment
Phase 6 - Data extraction and monitoring progress
Phase 7 - Data synthesis

Stage III–Reporting and dissemination

Phase 8 - The report and recommendations
Phase 9 - Getting evidence into practice

Fig. 2.1 Stages of a systematic review (Tranfield, Denyer & Smart, 2003)

In their later work, Denyer & Tranfield (2009) propose a similar approach to producing a systematic review. However, in this case, they reviewed the four core principles which are used as a basis for systematic reviews in medical science. Inspired by those principles, they offer four alternative principles for systematic reviews for use in management and organization studies. According to their suggestion, reviews should be tested for their transparency, inclusivity, explanatory and heuristic nature.

Before commencing the review, a review panel needs to be formed, including both practitioners of the field of study as well as academics. The three stages should be completed as a group effort, resolving any disputes along the way.

Stage I – Planning the review

The first step in any research project is to identify its focus. Involving stakeholders in defining the research questions may help to ensure the right questions are asked and increase the value of the results (Tranfield, Denyer, Marcos, & Burr, 2004; Petticrew, 2001).

Phase 2 highlights the need of a review protocol, which is an essential element in conducting a systematic review. It is a detailed plan of the research process, including its eligibility criteria for inclusion and exclusion of primary studies, quality measures, definition agreements etc. Scoping studies are conducted to determine the relevance and size of the review. In a business context, the scope of the research may also include unpublished studies, conference proceedings and/or industry trials. To determine the elements of the protocol, a pilot of sample sources may be helpful (Denyer & Tranfield, 2009). A strictly planned review, however, may be considered unacceptable due to its lack of openess to creativity of the researcher. To avoid limiting the researcher in their process of exploration, discovery and development, whilst also ensuring the minimization of researcher bias, the suggestion is a flexible approach including *a priori* steps, while leaving room for modifications to the protocol. Every modificiation produces a new version of the protocol in which the modification is recorded and explained. (Denyer & Tranfield, 2009; Brereton, Kitchenham, Budgen, & Khalil, 2007).

Stage II – Conducting the review

Based on the review protocol established in the planning stage, the relevant evidence is collected. This may be a time-consuming task as several databases need to be searched. Each source needs to be reviewed based on the inclusion and exclusion criteria. Reviewings may be done by multiple reviewers and disputes should be resolved within the review panel. Relevant sources are collected and a review on the full text is done. Also the quality of the sources is evaluated, to ensure the internal validity of the research. Quality checklists, such as the CASP Qualitative Checklist (Critical Appraisal Skills Programme, 2019) may be used to do so (Tranfield, Denyer, & Smart, 2003). Based on the full text review, the final selection is made. Each review round is documented with reasons for exclusions. Based on the finally selected sources, the research questions of the review are answered. Data extraction by means of data extraction forms is done at the end of this stage, resulting in the answers to each of the research questions as well as a two-stage data synthesization. In the first stage, a 'descriptive analysis' summarizes and categorizes the main characteristics of the relevant materials. A 'thematic analysis', in stage two, synthesizes the findings of the review.

Stage III – Reporting and dissemination

All previous steps need to be reported and decisions should be explained. The report requires an introduction with a problem statement and review questions, a description of the methodology and a summary of the evidence that was used including a two-stage report on the results. Furthermore, the report should contain a discussion of the results, a final conclusion, limitations of the research, practical implications and recommendations for future research (Denyer & Tranfield, 2009; Tranfield, Denyer, & Smart, 2003).

Case Study – Data-driven Requirements Elicitation: A Systematic Literature Review

To understand how the proposed approaches are applied in practice, an example of a systematic review was evaluated. The evaluated research is an unpublished manuscript submitted to the Springer Journal on Requirements Engineering and provided to me by my supervisor (Unknown, 2019). As per the title of the paper, it is claimed to be a systematic review. This section starts with an analysis of the paper, compared to the proposed approaches in the previous chapters, followed by a summary of the lessons learned by this analysis.

Context

Requirements elicitation traditionally relies on the feedback of stakeholders as primary sources of information. As a result of the increasing digitalization, there potentially are more dynamic, digital sources that may be used for requirements elicitation. The researchers investigated whether those unintended sources of information may be valuable for retrieving feedback in an automated way.

Objectives

The main research question was formulated as follows: how can requirements elicitation from dynamic data be supported through automation? The main research question was further divided into the following sub-research questions:

- RQ1: What types of dynamic data are used for automated requirements elicitation?
- RQ2: What types of techniques and technologies are used for automating requirements elicitation?
- RQ3: What are the outcomes of automated requirements elicitation?

Methods

The search for relevant sources was done in six electronic databases were selected as, together, they cover the top 10 information systems journals and conferences. Search strings were created and adapted to the search function of each database to find relevant peer-reviewed articles. A pilot study was done to establish agreement and consistency within the review panel. In the first-round screening, sources were evaluated based on their title, abstract and keywords. In the second round screening the full-text was reviewed by means of a review form. After the final selection of sources, an analytical framework was designed to extract data to answer the research questions.

Results

The results section provides an extensive descriptive analysis of the source selection, followed by an analysis of the studies as well as the answer to each research question.

RQ1: Mainly human-sourced data are used for data-driven requirements elicitation, in particular online reviews. The integration of domain knowledge with dynamic data may increase the quality and diversity of the results of an automated requirements elicitation, however further research should confirm this statement.

RQ2: The use of natural language complicates automated use. Data are analysed with the help of natural language processing techniques such as data cleaning, text normalization and feature extraction. Also, active learning and semi-supervised machine learning are applied to reduce the human effort of labelling data into predefined classes. Irrelevant and non-informative data lead to unbalanced class distribution, which may be solved by an oversampling technique or filtering out of the unusable data. Several supervised machine learning techniques are applied, depending on the problem. The researchers comment that a support-tool to choose the best algorithm would be useful. Moreover, they suggest that support of visualization of the outcomes would be a valuable tool to effectively make decisions based on the data. Limited research has been conducted in the field of process-mediated and machine-generated data sources. To evaluate the proposed artefacts, mainly controlled experiments were used as well as case studies, to a lesser degree.

RQ3: The majority of the reviewed studies proposed methods to automate functional and non-functional requirements elicitation, some at a more detailed level than others. The three activities performed to elicit requirements are: (1) identification and classification of requirements-related information, (2) identification of candidate features related to requirements and (3) elicitation of requirements. In most studies the solution was fully automated, however, most studies did not support the full process of requirements elicitation.

Conclusions

The review summarized the state-of-the-art works that investigated the use of dynamic data for requirements elicitation, as well as the methods to automate the process. In the field of potentially useful dynamic data, there is a clear dominance in human-sourced data. As those data are reliant on the use of natural language processing techniques and several other complications, few studies achieved to propose a full automation of the complete requirements elicitation process.

Evaluation
The researchers followed the guidelines for performing a systematic literature review in software engineering proposed by Kitchenham & Charters (2007), which are broadly in line with the guidelines proposed in the previous section. A review panel was formed before commencing the review and the methodology consisted of the three main stages: planning, conducting and reporting the review.

Stage I – Planning the review

1. Identification of the research need:
    a. Defining the main research question: By suggesting the potential of automating requirements elicitation based on dynamic data, the introduction identifies the need for a review. Besides a review of the efforts taken so far in business contexts, also existing research and, in particular, systematic reviews were evaluated. According to the authors, no systematic review with comparable aims has been performed. As part of the identification of the research need, the definitions and scope of the proposed systematic review are described to set a clear frame.
    b. Defining the sub-research questions: Following the identified research need, the main research question aims to satisfy this need by covering an existing gap in research. The sub-research questions each discuss an element related to the main research question. As the authors describe, by answering the sub-research questions they provide a holistic analysis of existing evidence, identify research gaps and are able to propose directions for future research. However, providing new knowledge by means of answering the main research question, is not mentioned as a manner to contribute to the growth of scientific knowledge. Synthesizing the results and failing to state how each sub-research question contributes to the main research question will result in failure to provide a solid answer to the main research question.
2. Developing a review protocol: A detailed protocol was generated to systematically guide the researchers through performing the review. The protocol includes the eligibility criteria, the search strategy and a framework for data collection. The eligibility criteria on the content of the study to include or exclude are in accordance with the definitions and scope as defined in the introduction. The inclusion and exclusion criteria in regards to the characteristics of the studies limit the number of results to include only the most valuable studies to the authors. The review protocol fails to include a quality assessment strategy to evaluate primary studies included in the review. Failing to include this step may endanger the validity of the review in terms of bias, internal validity and external validity; important elements of quality research. Moreover, quality assessment may be valuable for analysis and interpretation of the studies in a later stage of the review.

Stage II – Conducting the review

3. Defining the search strategy: As proposed in several guidelines, the search strategy was developed in consultation with experts in the field of research as well as in the field of study. In a systematic method, first the components of the research questions are extracted, closely related keywords and synonyms are identified and search strings by means of Boolean ANDs and ORs are constructed. The search strings were adapted and applied in the

databases that were discussed to be relevant for the review. Besides those databases, no other data sources were consulted.

4. Documenting the search: The section about data sources gives an overview of the actual search. By providing the exact search strategy, the selection of data sources as well as the date of the search, the search can be replicated.
5. Study selection: A flow diagram and a table with the number of results are shown in the report, documenting the selection of studies.
6. Study quality assessment: The researchers do not include a study quality assessment.
7. Data extraction: An analytical framework was created for extraction of relevant data to each research question. The use of an analytical framework ensures a systematic manner of extracting the right data.
8. Data synthesis:
    a. Descriptive analysis: The results section includes an extensive list of data sources, retrieval methods and requirements types and provides a holistic view of the included studies and data extracted from them.
    b. Thematic analysis: The researchers successfully summarized and synthesized the existing evidence to answer the sub-research questions. However, there is no clear description to explain to what extent the sub-research questions contribute to answering the main research question.

Stage III – Reporting and dissemination

9. Structuring the report:
    a. Conclusions: The conlclusion summarizes the research process. However, it fails to produce new knowledge by providing a solid answer to the main research question and presenting the relations between the topics representing each sub-research question. Would the researchers have focused on relating the topics, they would have produced more valuable and reusable knowledge in the field of requirements engineering.
    b. Recommendations for future research: The evaluated systematic review suggests numerous topics for future research, however, those topics are mainly hidden in the answers to research questions. Only a short paragraph at the end of the conclusions chapter is fully dedicated to the subject.
    c. Practical implications: Due to the absence of a solid answer to the main research question, the report also fails to imply the application of the results in practice.
    d. Limitations: The report lacks and evaluation of the studies' limitations. Therefore, it is hard to estimate to what extent the study is externally valid.
    e. Completing the report: The report is missing the following elements: results of the study quality assessment, recommendations for future research, practical implications and the limitations.
10. Dissemination: The report was submitted to the Journal on Requirements Engineering, an academic journal. It is not clear whether it was finally published. As the introduction highlights the potential of automated requirements elicitation from dynamic resources in practice, other forms of dissemination may be necessary to reach practitioners.

Lessons learned

1. Define the right sub-research questions: The sub-research questions contribute to answer the main research question and define the search strategy and study selection method. Therefore, they are a critical element of a systematic review. The sub-research questions may be subject to several rounds of review and evaluation on the extent to which they contribute to answering the main research question. The answer to each sub-research question should also contain a section to explain its significance to the main research question.
2. Look further than databases: When little scientific evidence is available, a search in the main digital databases may not be sufficient. To ensure thoroughness, references of primary sources may be consulted and special requests to experts in the field may be done.
3. Summarize significant results in respective chapters: As proposed by several methods discussed in the previous section, practical implications and suggestions for future research should be a substantial part of the reporting stage. Therefore, it is important to dedicate a chapter to both topics.
4. Prove the quality of the research: In a systematic review, quality is ensured in two parts. First, primary studies included in the review should be assessed on their quality, which starts with the development of a study quality strategy as part of the protocol. Second, the quality of the study itself should be confirmed by proving the relevance of each research question to answer the main research question.
5. Verify the applicability of the results: Offering the reader an explanation of limitations gives the reader direction to understand to what extent the results can be generalised and ensures external validity.
6. Choose the dissemination strategy to reach the right audience: If the results of the study intend to influence practitioners, it may be relevant to publish the results in press releases or online articles relevant to your audience, in addition to publishment of the full study in an academic journal.

RQ 2: How can the requirements of a support system, following the proposed approaches, be identified and modelled?

Eliciting requirements for a modelling technique that are needed to model a protocol of a systematic review starts with the establishment of goals (Roubtsova, 2016). A goal can be defined as a desired future state. Goal modelling helps us to understand why we need a system and defines relevant and complete goals and requirements (Maiden, 2005). It contributes to requirements eliciting by achieving requirements completeness, avoiding irrelevant requirements, providing a rationale for requirements, exploring alternative system proposals, managing conflicts in the case of conflicting goals, refining goals and deriving requirements (van Lamsweerde, 2001). The most prominent goal modelling techniques are i*, KAOS and UML.

The i* method is used to get a high-level understanding of stakeholder interests and how they may be addressed by the system (Yu & Mylopoulos, 1998). Whereas i* is mainly used during the earlier stages of the requirements engineering process, UML is focused on modelling functional goals. It was developed by Booch, Rumbaugh & Jacobson (2005), in an attempt to unify each of their own modelling languages. The Unified Modelling Language (UML) is a graphical language to write a systems blueprint. It offers a method to visualize, specify, construct and document conceptual and concrete models (Booch, Rumbaugh, & Jacobson, The Unified Modeling Language User Guide, 2005). KAOS is a methodology that allows to model goals for requirements engineering. The methodology also includes the evaluation of the model from different perspectives and helps to produce the adequate requirements documentation (Respect-IT, 2007).

Mcnelle & Simons (2006) describe protocol modelling as a modelling aproach that supports reusable behavioural abstractions. The term *protocol* refers to a sequence of occurences that are accepted by the model. A protocol system is composed of protocol machines. Protocol machines are abstractions of the model to guide the user through the sequences by submitting events, which reflect occurences in the real world (Mcneile & Simons, 2006).

According to the EXecuTable Requirements Management and Evolution model (ExtREME) (Roubtsova, 2016), goal modelling, requirements management and IMS are all elements of a cyclical process of model development, maintenance and evolution. One element of the methodology is protocol modelling. New elements can be added to the protocol model by means of the model development cycle, which may be initiated by goals, requirements or concepts derived from the applicable research domain. By means of behavioural modelling, each new element of the cycle is represented in a protocol machine.

A protocol machine is a conceptual machine that is able to accept or refuse a certain set of events, called its *repertoire*; an event that is not recognized is ignored, which means that the protocol machine is solely event driven. A quiescent state is reached when no further events are presented to the machine. A protocol system is composed of multiple protocol machines. The behaviour of the protocol system will be determined by the disposition of the event to each protocol machine (Mcneile & Simons, 2006).

Due to the predefined nature and systematic approach of a systematic review, a support model would be of high value to facilitate the process. The review protocol to follow while performing the review is established during the preparation phase of the review by choosing the best strategies to undertake each step. This characterizes the systematic review methodology and ensures its rigour, transparency and minimal chances of bias. Developing the protocol is a substantial part of the review. Several sample and scoping studies may be part of it and it should be subjected to version control (Brereton, Kitchenham, Budgen, & Khalil, 2007). This implies that the development of the review protocol is a significant effort, that includes several rounds of review and improvement before reaching the final status. The development of a protocol model replaces the review protocol developed as part of the systematic review methodology and also guide the researcher(s) through its execution.

2.3. Objective of the follow-up research

The follow-up research consists of the development and testing of a model based on the results of the previous section. Several rounds of development resulted in a final model following the methodology that was described. The data of the graduation project will be used as test data to evaluate the benefits that the use of the model would bring. As a second test, the case study that was performed as part of the results of research question 1 will be replicated and analysed according to the model as well.

3. Results

3.1. Goal model

To identify and visualize the requirements of a support system for executing a systematic review, a goal refinement tree was created (Fig. 3.1). A goal refinement tree consists of *Nodes*, representing goals and requirements, and *Arcs*, linking refined goals (“children”) to abstract goals (“parents”) (Roubtsova, 2016). The model was built using the results of the literature review and the case study presented in the previous section. The overall goal of the model is put on the top of the goal refinement tree, every step downwards provides a more refined goal; going upwards in the tree leads to abstraction of the goals. From refined goals, requirements are derived.

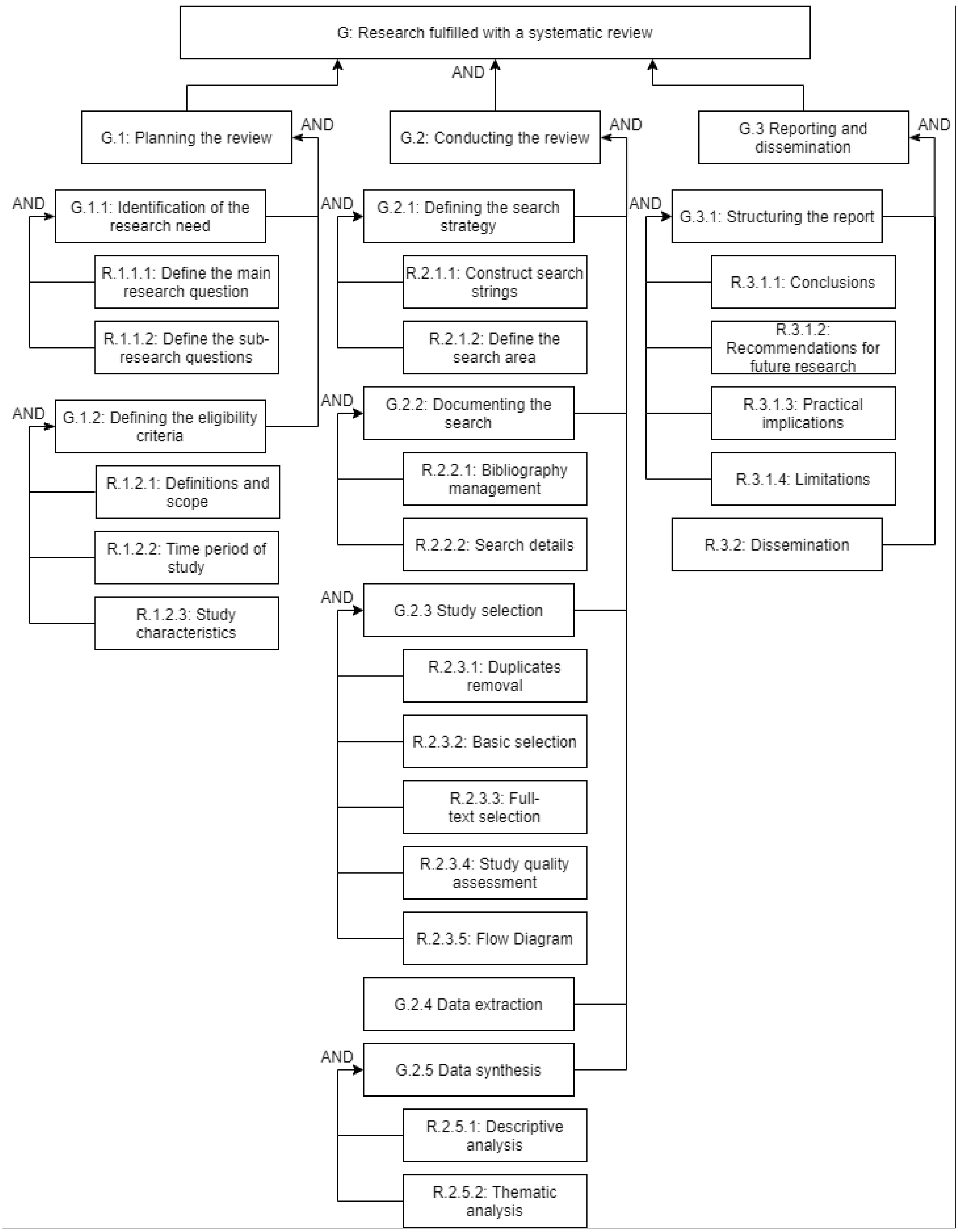

Fig. 3.1 Goal Refinement Tree, Support system: Research fulfilled with a systematic review

The Goal Refinement Tree (Fig. 3.1) represents a support system for a research project fulfilled by means of a systematic review. Each of them should be formulated according to the SMART method (specific, measurable, agreed, realistic, time bound). Before the research project is started, a review panel is formed. Within the review panel, there are different roles. Each of the roles may be covered by one or multiple researchers. A systematic review is built upon three main stages: G1: planning, G2: conducting and G3: reporting and dissemination of the review.

The model applies the *milestone decomposition* approach, which indicates that there is a specific order of the stages and sub-states. Nodes with ingoing arcs ("parents") are called *roots,* nodes without ingoing arcs ("children without children") are called *leafs*. A leaf is a requirement to reach a goal and a root is a refined goal to reach a more abstract goal, until the final goal is achieved. By following the order of leafs and roots as proposed in Fig. 3.2, the final goal of fulfilling a research project by means of a systematic review is reached.

G.1: Planning the review

G.1.1: Identification of the research need

R.1.1.1: Define the main research question
The combination of an interest or assumption with a literature review on the respective topic should result in the formulation of the main research question.

R.1.1.2: Define the sub-research questions
Splitting the main research question into elements identify the research question. Each research question needs to be formulated in accordance with the SMART method and it should be evaluated to what extent they contribute to answering the main research question.

G.1.2: Defining the Eligibility Criteria

R.1.2.1: Definitions and scope
Define each element identified in G.1.1 by describing what is and what is not measured. The combination of the definitions of each element of G.1.1 and the specification of study domais to include and exclude define the scope of the review. Translate the definitions and scope into inclusion and exclusion criteria based on the focus area of studies.

R.1.2.2: Time period of study
Choose the years of publication to include. The start of the time period may be selected by means of the first relevant study published. The end of the time period is by default the current year. In case of deviation, substantiation is required.

R.1.2.3: Study characteristics
Specify characteristics of studies to specifically include or exclude, such as peer-revision, language, research types and publication methods.

G.2: Conducting the review

G.2.1: Defining the search strategy

R.2.1.1: Construct search strings
The elements of the research questions are split into individual key words, followed by the formulation of a list of synonyms, abbrevations and alternative spellings. Search strings are contructed using the key words identified and Boolean ANDs and ORs. Search string may need to be adapted to the capabilities of each data source.

R.2.1.2: Define the search area
Identify the relevant data sources to apply the search strategy to. As a first step, the most significant digital databases in the domain of research should be identified. As a second step, other relevant data sources should be chosen depending on the study domain. Other relevant data sources in the field of management and organization

studies include special requests to important researchers and experts in the field of study, reference lists from relevant primary studies, company journals and conference proceedings.

G.2.2: Documenting the search

R.2.2.1: Bibliography management
To keep track of the large number of references, a bibliographic tool such as Endnote should be used.

R.2.2.2: Search details
To ensure replicability of the search, the exact steps taken need to be documented. During the search process, note at least the date of search, data source, search field and number of hits.

G.2.3: Study selection

R.2.3.1: Duplicates removal
After the search of studies has been performed, the duplicates should be removed. The number of excluded articles is noted in the flow diagram.

R.2.3.2: Basic selection
After the duplicates are removed, the eligibility criteria are applied to the title, abstract and keywords of the remaning articles. The number of excluded articles is noted in the flow diagram.

R.2.3.3: Full-text selection
After the selection based on title, abstract and keywords are removed, the eligibility criteria are applied to the full-text of the remaining articles . The number of excluded articles is noted in the flow diagram, including reasons for exclusion. This selection leads to the final selection of studies to include in the review.

R.2.3.4: Study quality assessment
The quality of a study is defined by its extent of minimising bias and maximizing internal and external validity. An existing quality checklist may be applied to evaluate the different types of studies included in the review. The quality assessment strategy should imply to what extent the results of a study should be weighted in the results of the review. The results of the assessment are considered during the synthesization and conclusions of the report.

R.2.3.5: Flow diagram
A flow diagram, including the reasons for exclusion, provides clear overview of the study selection. It starts with the sum of the number of hits of all data sources,, followed by the number of articles excluded by R.2.3.1 – 4.

R.2.4: Data extraction
By means of data extraction forms, data are extracted from each of the finally selected studies.

G.2.5: Data synthesis

R.2.5.1: Descriptive analysis
A descriptive analysis summarizes and categorizes the extracted data, as well as the

main characteristics of the selected studies, such as domain, region, year and volume of the research in a quantative matter.

R.2.5.2: Thematic analysis
The thematic analysis answers each sub-research question and links results across the included studies, emphasizing new knowledge that is produced.

G.3 Reporting and dissemination

G.3.1: Structuring the report

R.3.1.1: Conclusions
The conclusions answer the main research question and highlight other relevant results of the research.

R.3.1.2: Recommendations for future research
The recommendations for future research is one of the most valuable results of a systematic review. Based on the data synthesis (G.2.6), gaps in scientific evidence may be identified. Also, new assumptions and/or hypotheses may arise. Those findings are noted in the recommendations for future research.

R.3.1.3: Practical implications
The practical implications describe how the results of the review may be applied in practice.

R.3.1.4: Limitations
The limitations describe the shortcomings of the review, and if significant, the shortcomings of primary studies included in the review. This section of the report serves as a guideline for researchers and practitioners to understand to what extent the results may be applied.

R.3.2: Dissemination
The final academic report should be submitted to the chosen academic journal and/or conference. If the results of the review are intended to influence practice, it is relevant to share the outcomes with practitioners in the field. The right channels may be chosen based on the results of the review.

3.2. Concepts

To identify the concepts of the goal modelling that will serve as input for the protocol model, each node is converted to a protocol machine. During this exercise, also actors, events and transitions are identified. The general rules are: subjects are actors, nouns are concepts, verbs are events and the combination of concepts and events are transitions. Actors are underlined, concepts are marked in **bold** and events are marked in *italics*.

- G: The review panel *fulfils* **the review**
- G.1: The organizer *plans* **the review**
- G.1.1: The organizer *identifies* **the research need**
  - R.1.1.1: The organizer *defines* **the main research question**
  - R.1.1.2: The organizer *defines* **the sub-research questions**
- G.1.2: The organizer *defines* **the eligibility criteria**

- R.1.2.1: The <u>organizer</u> *defines* **the definitions and scope**
- R.1.2.2: The <u>organizer</u> *defines* **the time period of study**
- R.1.2.3: The <u>organizer</u> *defines* **the study characteristics**

- G.2: The <u>reviewer</u> *conducts* **the review**
- G.2.1: The <u>reviewer</u> *defines* **the search strategy**
  - R.2.1.1: The <u>reviewer</u> *constructs* **the search strings**
  - R.2.1.2: The <u>reviewer</u> *defines* **the search area**
- G.2.2: The <u>reviewer</u> *documents* **the search**
  - R.2.2.1: The <u>reviewer</u> *manages* **the bibliography**
  - R.2.2.2: The <u>reviewer</u> *records* **the search details**
- G.2.3: The <u>reviewer</u> *selects* **the documents**
  - R.2.3.1: The <u>reviewer</u> *removes* **duplicates**
  - R.2.3.2: The <u>reviewer</u> *reviews* **the documents** *based on title, abstract and key words*
  - R.2.3.3: The <u>reviewer</u> *reviews* **the documents** *based on the full-text*
  - R.2.3.4: The <u>reviewer</u> *assesses* **the documents** *based on the research quality*
  - R.2.3.5: The <u>reviewer</u> *produces* **the flow diagram**
- G.2.4: The <u>reviewer</u> *extracts* **data**
- G.2.5: The <u>reviewer</u> *synthesizes* **data**
  - R.2.5.1: The <u>reviewer</u> *produces* **a descriptive analysis**
  - R.2.5.2: The <u>reviewer</u> *produces* **a thematic analysis**
- G.3: The <u>reviewer</u> *reports and disseminates* **the review**
- G.3.1: The <u>reviewer</u> *structures* **the report**
  - R.3.1.1: The <u>reviewer</u> *produces* **the conclusion**
  - R.3.1.2: The <u>reviewer</u> *produces* **recommendations for future research**
  - R.3.1.2: The <u>reviewer</u> *produces* **practical implications**
  - R.3.1.2: The <u>reviewer</u> *produces* **limitations**
  - R.3.2: The <u>reviewer</u> *disseminates* **the report**

Simplification:

In order to simplify the model and make it generic to fit all research domains, the production of an actual report to disseminate will from now on be excluded. However, the elements needed to build it will be covered. As identified, systematic reviews in a business context may require to look further than digital databases. As the sources to look into highly depend on the research topic, this will be considered outside of the scope of this paper as well. The other identified concepts will be converted into objects and attributes.

The main object will be the *Review*. All other concepts, events and transitions will be linked to a *Review* instance. The *Main Research Question*, as well as the *Conclusion* will be added as attributes to the *Review.* The attributes will each be filled in at different states of the *Review* instance. A separate object will be needed for the *Sub-Research Questions*, to allow the user to add an undefined number of *Sub-Research Questions*. By adding the *Main-* and *Sub-Research Questions,* the *Research Need* is covered and will therefore not be added to the protocol model as a separate concept. The *Definitions and Scope* and *Study Characteristics* will be merged as two types of *Eligibility Criteria* in an object. As there must be exactly one *Time Period of* Study for the *Review,* it will be added as an attribute to the *Review* object. *Search* and *Search* strategy will be merged into one object, called *Search.* The object will record the *Search String, Search Area* and *Search Details*. *Documents* will be added as instances of the *Documents* object, including their reference details and place within the *Review*. This will build a *Bibliography* and allow tracking of the *Documents* to construct a *Flow Diagram.* In order to extract data, an object called *Key Points* will be created, in which the relevant findings of a *Document* can be recorded. The *Descriptive* and *Thematic Analyses* can be constructed based on the recorded *Documents* and *Key Points*; therefore, they will not be explicitly visible in the protocol model. *Recommendations for Future Research* as well as *Practical Implications*, will be added as attributes to the *Review* to be able to record the contribution of the *Review.* The *Limitations* may be derived from the *Eligibility Criteria* and will therefore not be visible in the protocol model.

3.3. Protocol Model

A protocol model, called Support System for a Systematic Review (SRSS), was developed to support the execution of a systematic literature review. A first set of objects and attributes to model were identified based on the identified concepts in chapter 3.2. Several rounds of improvements were conducted to come to the final model. The full model is visualized in Fig. 3.2. The actual model, as well as the included Java callbacks, can be found in, respectively, Appendix 1, 2 and 3. The tool Modelscope may be used to run the model.

By submitting all events to the model, the users are transited through the full research process until the final quiescent state *Completed* is reached.

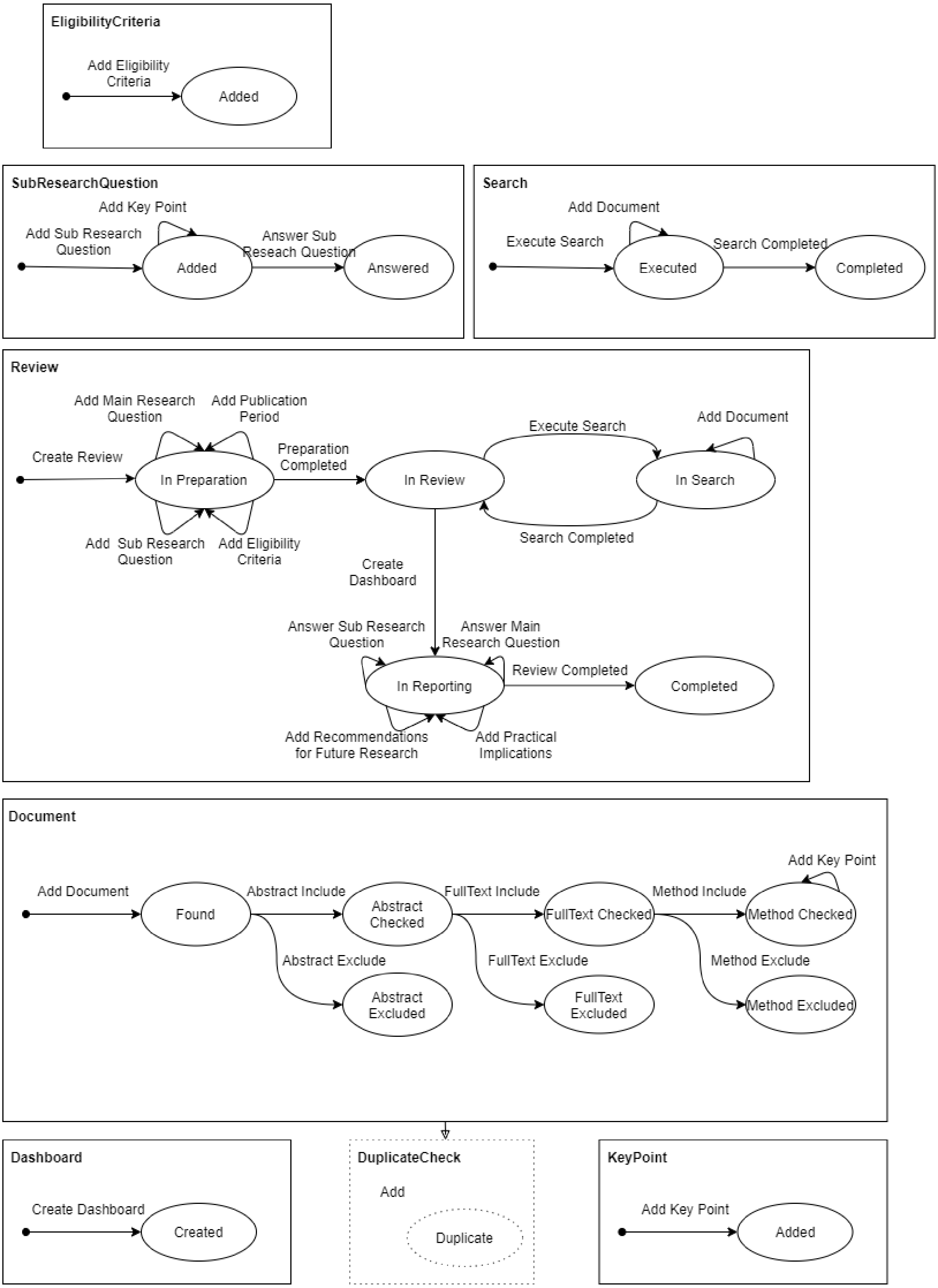

Fig. 3.2 Visualization of the Systematic Review Support System model

The model is used by two actors; the *Organizer* and the *Reviewer*. The *Organizer* is responsible for the preparation of the systematic review, in which the aim and scope of the research are defined.

Review

The main object of the model is the *Review*. The *Review* is started by the *Create Review* event. By this event, an instance of a *Review* is created in its first state; *In Preparation*. As an attribute of the *Review*, the *Main Research Question* is added by the *Add Main Research Question* event.

The event *Add Publication Period* is used to define the *Time of Publication Start* and *End* of the *Review. Add Eligibility Criteria* creates instances of *EligibilityCriteria* to *Include: True* or *False*. Those two events define the scope of the review. The *Preparation Completed* event finishes the work of the Organizer and brings the *Review* to the next state; *In Review.*

In this state, the *Reviewer* takes over. The *Reviewer* executes the searches and is responsible for reporting the research. Each instance of the *Search* object is created in the *Executed* state by the *Execute Search* event and defined with its *Database, Search String* and *Executed on* date attributes. During the execution of a *Search*, the *Review* is moved to the *In Search* state. During the *In Search* state, the *Add* Document event allows to add instances in the *Document* object. When all *Documents* are recorded, the *Search Completed* event loops the *Review* back to the *In Review* state, from which another *Search* can be started, or the next state can be initiated.

When all searches are completed and all documents are added and reviewed, the *Review* is moved to the next state; *In Reporting.* To do so, the event *Create Dashboard* is used, which creates a dashboard of the number of documents that were found, excluded at each step and finally included in the review. The dashboard contains several integer attributes that are calculated by Java callbacks.

At this point, the *Reviewer* is ready to finalize the reporting. The following events are executed and attributes are filled in; *Answer Sub Research Question* which constructs the answer based on the collected *KeyPoints* in the *Answer* attribute of *SubResearchQuestion; Answer Main Research Question* which defines the answer to the main research question, based on the answers to each sub research question in the *Conclusion* attribute*; Add Recommendations for Future Research* which allows the *Reviewer* to suggest areas for further investigation in the *Future Recommendations* attribute and *Add Practical Implications* which allows the *Reviewer* to explain how the results of the review can be applied in practice in the *Practical Implications* attribute. When all other events are executed, the *Review Completed* event brings the *Review* to its final quiescent state; *Completed.*

The steps are visualized in Fig. 3.3.

Actor(s):

- Organizer
- Reviewer

Attributes:

- Review Name
- Main Research Question
- Time of Publication Start

- Time of Publication End
- Conclusion: The answer to the Main Research Question.
- Recommendations for Future Research
- Practical Implications

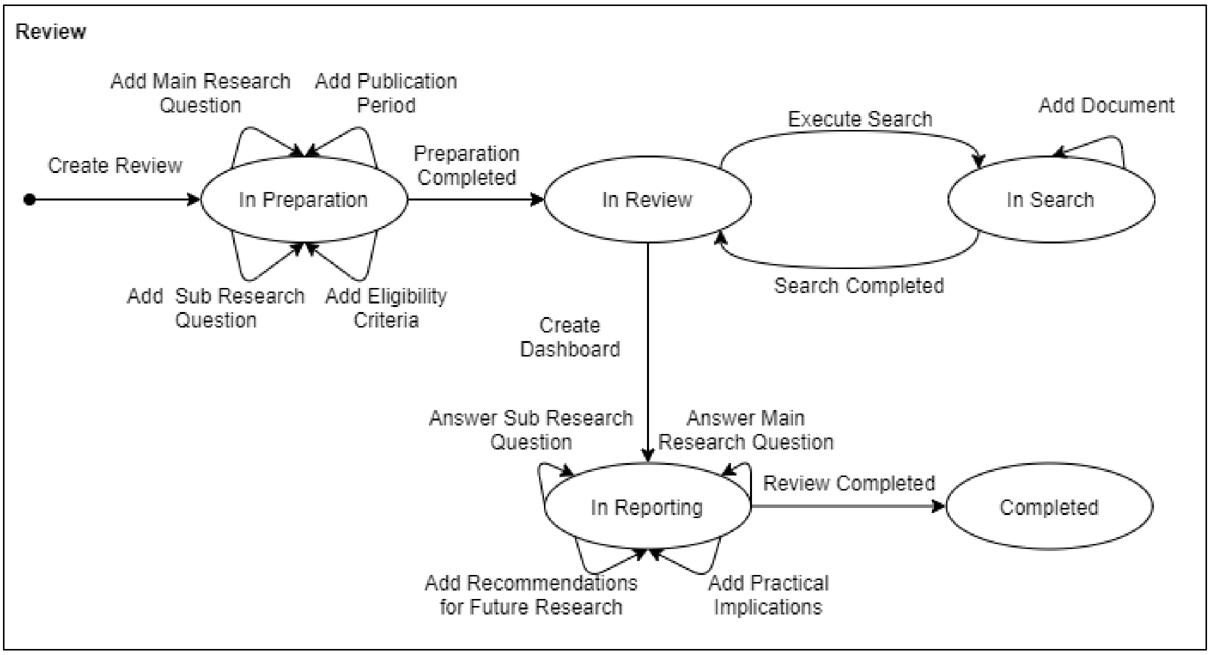

Fig. 3.3 Review object

Sub-Research Question

Multiple sub-research questions may be created and related to the *Review* by the *Add Sub Research Question* event. Each of those events creates a new instance in the *SubResearchQuestion* object, in the state *Added.* While adding a sub research question, the user defines the *Relevance to Main Research* question. While the *SubResearchQuestion* is in the *Added* state, *KeyPoints* may be added by the *Add Key Point* event. The event *Answer Sub Research Question* constructs the answer based on the collected *KeyPoints* in the *Answer* attribute and moves the instance to the state *Answered.*

The steps are visualized in Fig. 3.4.

<u>Actor(s):</u>

- Organizer

<u>Attributes</u>:

- Sub-Research Question
- Relevance to the Main Research Question: An explanation about the relevance of the question asked, in relation to the Main Research Question
- Answer: The answer to the Sub-Research Question
- Review: The reference to the *Review* object

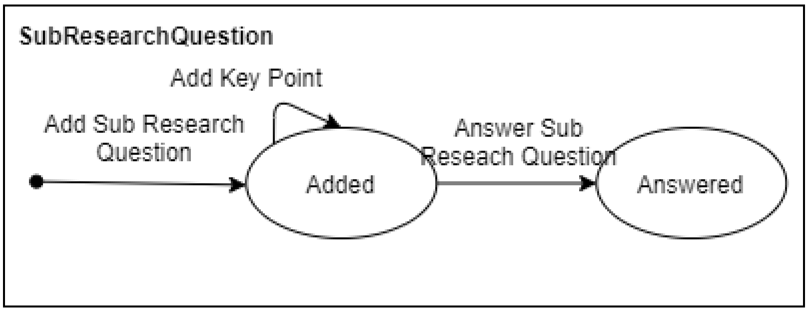

Fig. 3.4 SubResearchQuestion object

Eligibility Criteria

Add Eligibility Criteria creates instances of *EligibilityCriteria* to *Include: True* or *False*. *EligibilityCriteria* define the scope of the review, in addition to the *Publication Period* that is set on the *Review* object. Each instance of an *EligibilityCriteria* affects the scope of the review. Therefore, the *EligibilityCriteria* can also produce limitations.

The steps are visualized in Fig. 3.5.

Actor(s):

- Organizer

Attributes:

- Eligibility Criteria
- Include: A Boolean to define whether documents that comply with the criteria need to be in- or excluded from the Review.
- Review: The reference to the *Review* object

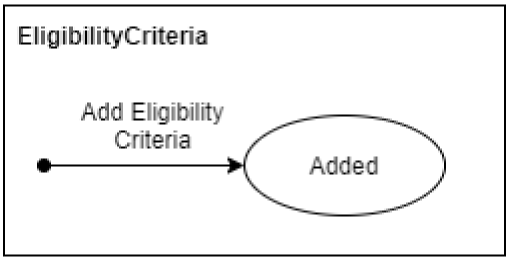

Fig. 3.5 EligibilityCriteria object

Search

A *Search* is created in the *Executed* state by the *Execute Search* event. At the same time, the search details; *Database, Search String* and *Executed* on date are recorded, which allows the search to be replicated. Each *Document* that is found is recorded as an instance in the *Document* object by the *Add Document* event. When all *Documents* are recorded, the *Search Completed* event brings the *Search* to the quiescent *Completed* state.

The steps are visualized in Fig. 3.6.

Actor(s):

- Reviewer

Attributes:

- Database: The database in which the search takes place.
- Search String: The string that is used to search, constructed by several key words.
- Executed on: The date of the search.
- Review: The reference to the *Review* object

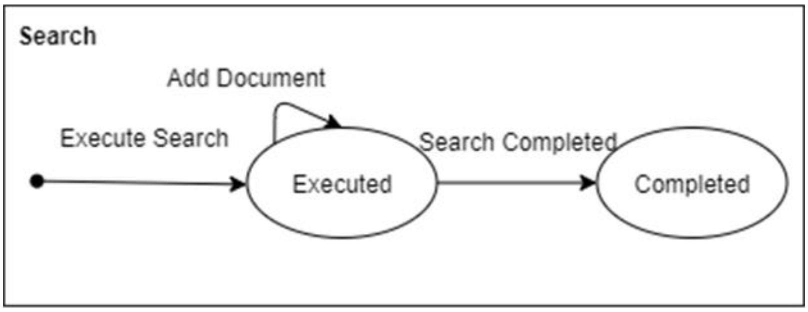

Fig. 3.6 Search object

Document

The results of each search are recorded in the support system as instances of the *Document* object. A *Document* is added by the *Add Document* event in the *Found* state, together with the *Document Title* and *Reference Details.* The included *Duplicate Check* prevents the user from adding duplicate *Documents* based on the *Document Title*.

Each *Document* runs through a thorough evaluation process during which it can be excluded from the review. As a first step in the evaluation process, the title, key words and abstract of the article are checked. If the defined eligibility criteria are not matched, the *Document* is excluded after this state without further definition of reasons by the *Abstract Exclude* event, which brings the *Document* to the quiescent *Abstract Excluded* state. In contrast, the *Abstract Include* event brings the instance to the *Abstract Included* state if the eligibility criteria are matched. If the instance has reached the *Abstract Included* state, the next step is to review the full text of the article. *FullText Exclude* brings the instance to the quiescent *FullText Excluded* state, together with the *Reason for Exclusion. FullText Include* brings the instance to the *FullText Included* state. If the instance reaches the *FullText Included* state, the research method is evaluated to ensure the reliability of the research. If the research is considered of sufficient quality, the *Method Include* event includes the instance in the review and defines its *Research Method*. *Method Exclude* brings an instance to the quiescent *Method Excluded* state while defining the *Research Method* and *Reason for Exclusion.* When a *Document* reaches the *Method Included* state, it will be included in the review. At this point, instances of the *KeyPoint* object may be added by the *Add Key Point* event.

The steps are visualized in Fig. 3.7.

Actor(s):

- Reviewer

Attributes:

- Document Title
- Reference Details
- Reason for Exclusion
- Research Method
- Review : reference to the *Review* object

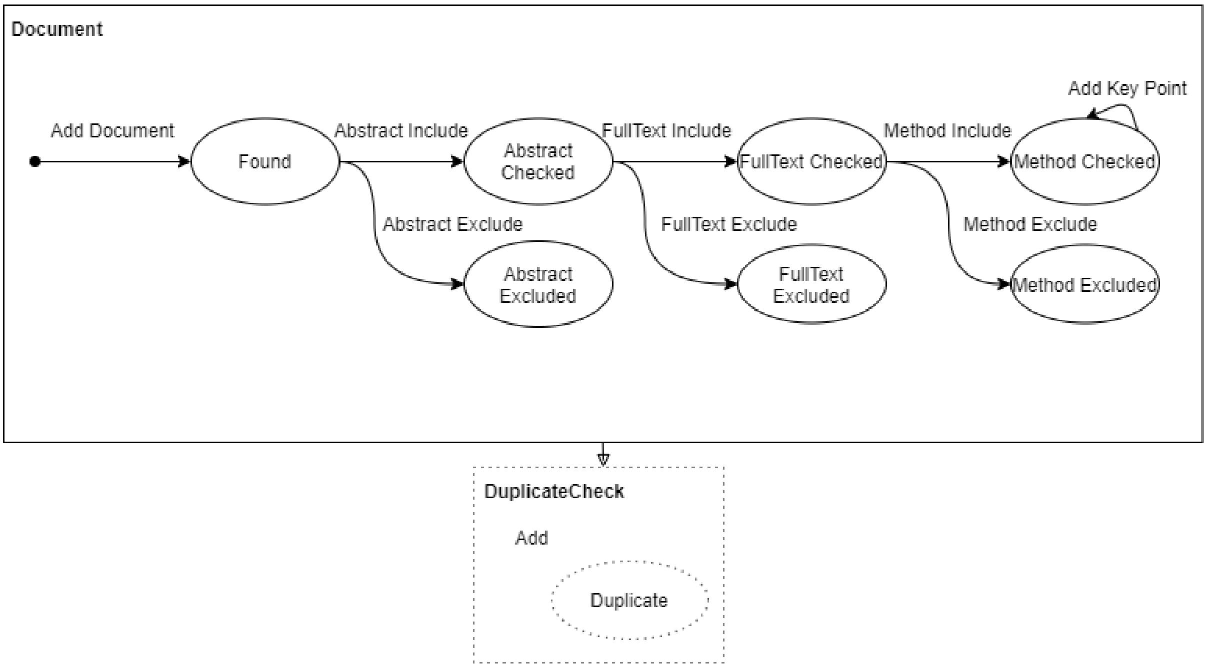

Fig. 3.7 Document object

Key Point

To extract data from *Documents*, *KeyPoints* are added. A *KeyPoint* Is a finding that contributes to answer the research questions of the review. Each *KeyPoint* is added with the *Add Key Point* event. The *KeyPoint* object only has one state; *Found* and three attributes; a string to record the *Key Point* and references to the *Document* in which it is found and *SubResearchQuestion* that it contributes to answering.

The steps are visualized in Fig. 3.8.

Actor(s):

- Reviewer

Attributes:

- Key Point

- Document: reference to the *Document* object
- Sub-Research Question: reference to the *SubResearchQuestion* object

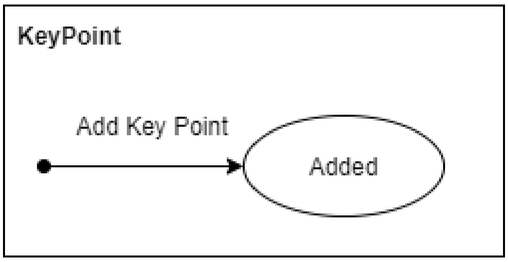

Fig. 3.8 KeyPoint object

Dashboard

The *Dashboard* provides an overview of found and in- and excluded *Documents*. Based on the *Dashboard*, a flow diagram can be created. The event *Create Dashboard* is used to create the *Dashboard* and run the Java callbacks that calculate the integers to fill in the attributes.

The steps are visualized in Fig. 3.9.

Actor(s):

- Reviewer

Attributes:

- Dashboard Name
- Review → reference to the *Review* object
- Number of Hits
- Number of Excluded Documents based on Abstract
- Number of Excluded Documents based on Full-Text
- Number of Excluded Documents based on Research Method
- Final Number of Included Documents

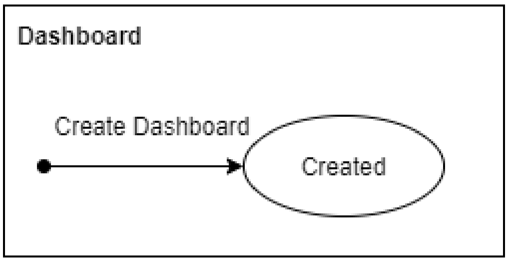

Fig. 3.9 Dashboard object

4. Testing & Analysis of the Protocol Model

Throughout the development, several tests were completed to come to the final model. Two full tests of the model are presented in this paper. The first test represents a sample of the data used in this study and evaluates the use of the model in the research domain. The second test represents a sample of the data of the systematic review that was evaluated in chapter 2.2, which is a systematic review undertaken in the domain of requirements engineering.

By testing the model and inputting data, the following use cases were identified:

1. Preparing the Review
2. Conducting and Recording Searches
3. Extracting Data
4. Creating a Dashboard
5. Reporting the Review

By following each of the identified use cases, all essential aspects of the systematic review process are covered.

In the following two chapters, the use cases are presented in tables. To replicate a test, the actor, object and instance need to be chosen as stated above each table. Accordingly, the events must be followed in the order as presented in the table. In combination with each event, there are certain attributes that are presented in the support system. The input column of the table shows what the input of each attribute should be.

Not visible in the test sequences, are the Java callbacks, running in the system's background. Two Java callbacks are included in the system:

- **DuplicateCheck**

This Java callback is a behaviour that is included in the *Document* object. Based on the *Document Title* it detects duplicate input. In the case of the creation of a *Document* instance, with a *Document* Title which is the same as the *Document Title* of an already existing *Document* instance, the creation of the new instance will be blocked.

- **Dashboard**

The Java callback *Dashboard* runs upon the *Create Dashboard* event and calculates the total number of documents found, the number of documents excluded at each step and the number of documents that are finally included in the review. Based on the dashboard, a flow diagram can be created.

They underlined texts in the tables are references to instances of objects.

4.1.1. Test 1: Graduation Project

As a first test, a sample of the data of this study was used. The use cases presented below represent a systematic review in the research domain.

Use Case: Preparing the Review

Actor: Organizer
Object: Review
Instance: (new Review) and continue in the created Review Instance

Event	Attribute(s)	Input
Create Review	Review Name	Graduation Project

Add Main Research Question	Main Research Question	What is the protocol and what are the abstractions of a support system executing the protocol of a systematic review?
Add Sub Research Question	Sub Research Question	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Relevance to Main Research Question	This question aims to understand the process of a systematic review.
Add Sub Research Question	Sub Research Question	RQ 2: How can the requirements of a support system, following the proposed approaches, be identified and modelled?
	Relevance to Main Research Question	This question aims to understand how requirements of a support system for executing a systematic review can be identified.
Add Publication Period	Time of Publication Start	1 Jan 1990
	Time of Publication End	31 Dec 2019
Add Eligibility Criteria	Eligibility Criteria	The document should be written in English
	Include	True
Add Eligibility Criteria	Eligibility Criteria	The subject research method should be systematic review
	Include	True
Add Eligibility Criteria	Eligibility Criteria	The study is not published
	Include	False
Preparation Completed	N/A	N/A

Use Case: Conducting and Recording a Search

Actor: Reviewer
Object: Search
Instance: (new Search) and continue in the created Search Instance

Event	**Attribute(s)**	**Input**
Execute Search	Review	Graduation Project
	Database	Google Scholar
	Search String	Systematic Review Guidelines
	Executed on	10 Nov 2019
Add Document	Review	Graduation Project
	Document Title	Producing a Systematic Review
	Reference Details	Denyer, D., & Tranfield, D. (2009). Producing a Systematic Review. In The SAGE handbook of organizational research methods (pp. 671-689). London: Sage Publications Ltd.
Add Document	Review	Graduation Project

	Document Title	Understanding systematic reviews and meta-analysis
	Reference Details	Akobeng, A. K. (2005). Understanding systematic reviews and meta-analysis. Archives of disease in childhood, 90(8), 845-848.
Add Document	Review	Graduation Project
	Document Title	Research Methods for Business Students
	Reference Details	Saunders, M., Lewis, P., & Thornhill, A. (2016). Research Methods for Business Students (7th ed.). Harlow: Pearson.
Add Document	Review	Graduation Project
	Document Title	Test 1 Abstract Excluded
	Reference Details	Test Reference 1
Add Document	Review	Graduation Project
	Document Title	Test 2 Full-Text Excluded
	Reference Details	Test Reference 2
Add Document	Review	Graduation Project
	Document Title	Test 3 Method Excluded
	Reference Details	Test Reference 3
Search Completed	Review	Graduation Project

Use Case: Extracting Data

Actor: Reviewer
Object: Document
Instance: Loop through each Document Instance

Document Instance 1: Producing a Systematic Review

Event	**Attribute(s)**	**Input**
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	Literature Review
Add Key Point	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Key Point	The idea of EBMgt is obstructed by misconceptions which is partly due to misunderstandings in terms of the way to conduct and use systematic reviews.
Add Key Point	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?

	Key Point	In a business context, the scope of the systematic review may also include unpublished studies, conference proceedings and/or industry trials. To determine the elements of the protocol, a pilot of sample sources may be helpful.
Add Key Point	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Key Point	Every modification to the review protocol produces a new version of the protocol in which the modification is recorded and explained.

Document Instance 2: Understanding systematic reviews and meta-analysis

Event	**Attribute(s)**	**Input**
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	Literature Review
Add Key Point	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Key Point	A systematic review follows a predefined approach. Besides ensuring comprehensiveness, following a predefined approach reduces the chance of bias and error.
Add Key Point	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Key Point	The inclusion and review of all potentially relevant materials is of high importance. A list of ten provided questions may be used to appraise a systematic review.

Document Instance 3: Research Methods for Business Students

Event	**Attribute(s)**	**Input**
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	Study Book
Add Key Point	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Key Point	The approach of a systematic should include a rigorous search for primary studies, the selection of studies based on clear and reproducible eligibility criteria, critical quality review of primary studies and synthesis of results according to a predetermined and explicit method.

Document Instance 4: Test 1 Abstract Excluded

Event	Attribute(s)	Input
Abstract Exclude	N/A	N/A

Document Instance 5: Test 2 Full-Text Excluded

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Exclude	Reason for Exclusion	Full-Text is not in English

Document Instance 6: Test 3 Method Excluded

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
Method Exclude	Research Method	Case Study
	Reason for Exclusion	The study is not published

Use Case: Create a Dashboard

Actor: Reviewer
Object: Review
Instance: Graduation Project

Event	Attribute(s)	Input
Create Dashboard	Dashboard Name	Graduation Project

Use Case: Reporting the Review

Actor: Reviewer
Object: Review
Instance: Graduation Project

Event	Attribute(s)	Input
Answer Sub Research Question	SubResearchQuestion	RQ 1: What are the proposed approaches of conducting a systematic review and what methods are used?
	Answer	A systematic review consists of three main stages….
Answer Sub Research Question	SubResearchQuestion	RQ 2: How can the requirements of a support system, following the proposed approaches, be identified and modelled?
	Answer	The first step to identifying requirements of a system is to create a goal model…
Answer Main Research Question	Conclusion	A protocol model is developed and tested…

Add Recommendations for Future Research	Recommendations for Future Research	xxx
Add Practical Implications	Practical Implications	xxx
Review Completed	N/A	N/A

4.1.2. Test 2: Replication according to SRSS – Data-driven Requirements Elicitation: A Systematic Literature Review

The case study that was executed as part of chapter 2.2 was repeated, however, this time, the research was replicated according to the model. The aim of the test was to determine whether the gaps that were identified during the case study could be closed by the use of the model. After the representation of the tests, the differences with the original research were evaluated. This test represents a test in the domain of requirements engineering.

Use Case: Preparing the Review

Actor: Organizer
Object: Review
Instance: (new Review) and continue in the created Review Instance

Event	**Attribute(s)**	**Input**
Create Review	Review Name	Data-driven Requirements Elicitation: A Systematic Literature Review
Add Main Research Question	Main Research Question	How can requirements elicitation from dynamic data be supported through automation?
Add Sub Research Question	Sub Research Question	What types of dynamic data are used for automated requirements elicitation?
	Relevance to Main Research Question	Exploration of the concept of dynamic data in relation to automated requirements elicitation
Add Sub Research Question	Sub Research Question	What types of techniques and technologies are used for automating requirements elicitation?
	Relevance to Main Research Question	Exploration of the concept of automation in relation to automated requirements elicitation
Add Sub Research Question	Sub Research Question	What are the outcomes of automated requirements elicitation?
	Relevance to Main Research Question	Irrelevant to the Main Research Question
Add Publication Period	Time of Publication Start	1 Jan 1996
	Time of Publication End	31 Dec 2019
Add Eligibility Criteria	Eligibility Criteria	Requirements elicitation is supported through automation.

	Include	True
Add Eligibility Criteria	Eligibility Criteria	Requirements are elicited from digital and dynamic data sources.
	Include	True
Add Eligibility Criteria	Eligibility Criteria	The article has been peer-reviewed.
	Include	True
Add Eligibility Criteria	Eligibility Criteria	Requirements are elicited solely from non-dynamic data.
	Include	False
Add Eligibility Criteria	Eligibility Criteria	The proposed method is performed based on existing requirements.
	Include	False
Add Eligibility Criteria	Eligibility Criteria	Studies that merely presented the proposed artefact without any or sufficient descriptions of evaluation methods.
	Include	False
Preparation Completed	N/A	N/A

Use Case: Conducting and Recording Multiple Searches

Actor: Reviewer
Object: Search
Instance: (new Search) and continue in each created Search Instance

Search Instance 1: Scopus

Event	**Attribute(s)**	**Input**
Execute Search	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Database	Scopus
	Search String	(requirements elicitation OR requirements analysis OR requirements identification OR requirements discovery OR requirements gathering OR requirements determination OR requirements collection OR requirements engineering OR system requirements) OR (automat* OR computer aided OR computer assisted) OR (big data OR sensor* OR Internet of Things OR IoT OR natural language processing OR data mining OR artificial intelligence OR data processing OR data science OR data analysis OR machine learning OR data driven OR data oriented OR graph analytics)
	Executed on	5 Dec 2018
Add Document	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Requirements engineering: fundamentals, principles, and techniques

	Reference Details	K. Pohl, Requirements engineering: fundamentals, principles, and techniques. Heidelberg ; New York: Springer, 2010.
Add Document	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Requirements elicitation techniques: a systematic literature review based on the maturity of the techniques
	Reference Details	C. Pacheco, I. García, and M. Reyes, Requirements elicitation techniques: a systematic literature review based on the maturity of the techniques, IET Software, vol. 12, no. 4, pp. 365–378, 2018.
Add Document	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Business Intelligence and Analytics: From Big Data to Big Impact
	Reference Details	H. Chen, R. H. L. Chiang, and V. C. Storey,Business Intelligence and Analytics: From Big Data to Big Impact, MIS Quarterly, vol. 36, no. 4, pp. 1165–1188, 2012.
Search Completed	Review	Data-driven Requirements Elicitation: A Systematic Literature Review

Search Instance 2: Web of Science

Event	Attribute(s)	Input
Execute Search	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Database	Web of Science
	Search String	(requirements elicitation OR requirements analysis OR requirements identification OR requirements discovery OR requirements gathering OR requirements determination OR requirements collection OR requirements engineering OR system requirements) OR (automat* OR computer aided OR computer assisted) OR (big data OR sensor* OR Internet of Things OR IoT OR natural language processing OR data mining OR artificial intelligence OR data processing OR data science OR data analysis OR machine learning OR data driven OR data oriented OR graph analytics)
	Executed on	5 Dec 2018
Add Document (blocked by DuplicateCheck)	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Requirements engineering: fundamentals, principles, and techniques

	Reference Details	K. Pohl, Requirements engineering: fundamentals, principles, and techniques. Heidelberg ; New York: Springer, 2010.
Add Document	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Re-expressing Business Processes Information from Corporate Documents into Controlled Language
	Reference Details	B. Manrique-Losada, C. M. Zapata-Jaramillo, and D. A. Burgos,Re-expressing Business Processes Information from Corporate Documents into Controlled Language, in Natural Language Processing and Information Systems, 2016, pp. 376–383.
Search Completed	Review	Data-driven Requirements Elicitation: A Systematic Literature Review

Search Instance 3: EBSCOhost

Event	**Attribute(s)**	**Input**
Execute Search	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Database	EBSCOhost
	Search String	(requirements elicitation OR requirements analysis OR requirements identification OR requirements discovery OR requirements gathering OR requirements determination OR requirements collection OR requirements engineering OR system requirements) OR (automat* OR computer aided OR computer assisted) OR (big data OR sensor* OR Internet of Things OR IoT OR natural language processing OR data mining OR artificial intelligence OR data processing OR data science OR data analysis OR machine learning OR data driven OR data oriented OR graph analytics)
	Executed on	21 Dec 2018
Add Document	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Establishing Reusable Requirements Derived from Laws and Regulations for Medical Device Development
	Reference Details	D. Hauksdóttir, B. Ritsing, J. C. Andersen, and N. H. Mortensen,Establishing Reusable Requirements Derived from Laws and Regulations for Medical Device Development, in 2016 IEEE 24th International Requirements Engineering Conference Workshops (REW), 2016, pp. 220–228.

Add Document	Review	Data-driven Requirements Elicitation: A Systematic Literature Review
	Document Title	Using domain ontology as domain knowledge for requirements elicitation
	Reference Details	H. Kaiya and M. Saeki,Using domain ontology as domain knowledge for requirements elicitation, presented at the Proceedings of the IEEE International Conference on Requirements Engineering, 2006, pp. 186–195.
Search Completed	Review	Data-driven Requirements Elicitation: A Systematic Literature Review

Use Case: Extracting Data

Actor: Reviewer
Object: Document
Instance: Loop through each Document Instance

Document Instance 1: Requirements engineering: fundamentals, principles, and techniques

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	xxx
Add Key Point	SubResearchQuestion	What types of dynamic data are used for automated requirements elicitation?
	Key Point	xxx

Document Instance 2: Requirements elicitation techniques: a systematic literature review based on the maturity of the techniques

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	xxx
Add Key Point	SubResearchQuestion	What types of dynamic data are used for automated requirements elicitation?
	Key Point	xxx

Document Instance 3: Business Intelligence and Analytics: From Big Data to Big Impact

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	xxx

Add Key Point	SubResearchQuestion	What types of techniques and technologies are used for automating requirements elicitation?
	Key Point	xxx

Document Instance 4: Re-expressing Business Processes Information from Corporate Documents into Controlled Language

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	xxx
Add Key Point	SubResearchQuestion	What types of techniques and technologies are used for automating requirements elicitation?
	Key Point	xxx

Document Instance 5: Establishing Reusable Requirements Derived from Laws and Regulations for Medical Device Development

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	xxx
Add Key Point	SubResearchQuestion	What are the outcomes of automated requirements elicitation?
	Key Point	xxx

Document Instance 6: Using domain ontology as domain knowledge for requirements elicitation

Event	Attribute(s)	Input
Abstract Include	N/A	N/A
FullText Include	N/A	N/A
Method Include	Research Method	xxx
Add Key Point	SubResearchQuestion	What are the outcomes of automated requirements elicitation?
	Key Point	xxx

Use Case: Create a Dashboard

Actor: Reviewer
Object: Review
Instance: Data-driven Requirements Elicitation: A Systematic Literature Review

Event	Attribute(s)	Input
Create Dashboard	Dashboard Name	Data-driven Requirements Elicitation: A Systematic Literature Review

Use Case: Reporting the Review

Actor: Reviewer
Object: Review
Instance: Data-driven Requirements Elicitation: A Systematic Literature Review

Event	Attribute(s)	Input
Answer Sub Research Question	SubResearchQuestion	What types of dynamic data are used for automated requirements elicitation?
	Answer	Existing research on data-driven requirements elicitation from dynamic data sources has primarily focused on utilizing human-sourced data in the form of online reviews, microblogs, online discussions/forums, software repositories, and mailing lists. Use of online reviews was substantially more prevalent, compared to other types of human-sourced data. App reviews...
Answer Sub Research Question	SubResearchQuestion	What types of techniques and technologies are used for automating requirements elicitation?
	Answer	Techniques used for the automated requirement elicitation Human-sourced data is typically expressed in natural language, which is inherently difficult to analyse computationally due to its lack of rigid structure and ambiguous nature. In all the selected studies...
Answer Sub Research Question	SubResearchQuestion	What are the outcomes of automated requirements elicitation?
	Answer	About 70% of the studies have proposed methods to support the automated elicitation of both functional and non-functional requirements. A majority of them have…
Answer Main Research Question	Conclusion	We have conducted a systematic literature review concerning requirements elicitation from data generated via digital technologies that are unintended with respect to requirements. These sources can include data…
Add Recommendations for Future Research	Recommendations for Future Research	N/A
Add Practical Implications	Practical Implications	N/A
Review Completed	N/A	N/A

During the preparation phase of this systematic review, it becomes clear that the sub-research questions aim to describe and analyse the current situation, opposed to the main research question, which aims to describe a desired or future situation. In the original research project, this finding was missed because it was not explicitly evaluated. Moreover, by the use of the model, the third sub-research question was identified as irrelevant to the main research question. If this would have been spotted by the authors, they could have rephrased the main or sub-research question, to show a logical sequence of questions.

Although the original study, included clear criteria to in- and exclude studies, there is no guidance on ensuring research quality. By following the model, each document runs through a three-step screening process, of which the last step is to confirm the quality of the document. This, together with the relevance of the research questions that is determined, ensures the quality of the review.

The use of the model aims to provide valuable results. Rather than summarizing existing knowledge, the model ensures that the main research question is answered and that the results of the review contribute to the academic as well as the business environment by adding recommendations for future research as well as practical implications. As identified in chapter 2.2, the original review study fails to answer the main research question. Moreover, it is missing recommendations for future research and practical implications. The model is explicitly asking for input regarding those components.

5. Discussion & Reflection

The research started with thoroughly understanding the steps needed to complete a systematic review. Based on the research a complete protocol model was created. The initial model included every node of the goal model, without simplification or clarification on what was expected. Throughout several rounds of improvement, the model was simplified and domain specific steps were excluded. In order to do so, some parts were identified as being outside the scope of the research, other parts were merged together or renamed to create an intuitive model to be used by practitioners.

The parts that were considered outside of scope are the creation of the review report and dissemination. In order to provide a model to complete those two steps of a systematic review as well, it would need to be evaluated in what way to add it to the model, which will depend on the domain of the research study. Parts that were merged were, for example, definitions and scope and study characteristics, which were identified by the goal model and merged together into eligibility criteria in the protocol model. Also, several steps included in the definition of the search strategy and documentation of the search in the goal model were merged together into one event (Execute Search) in the protocol model.

The final protocol model covers the minimum steps of a systematic review. The user of the model is guided through the steps, to ensure that a review that is conducted by means of the developed model, which covers the key aspects. Moreover, it helps to identify defects, such as:

1. Irrelevant sub-research questions, by the requirement of explaining the relevance to the main research question;
2. Duplicate search results, by the integrated duplicate check which prevents adding a second document with the same title as an already included document and
3. Missing or unsuitable conclusions, by the inclusion of a step to answer each sub-research question as well as the main research question.

The protocol model presented in this paper, may be used to identify the requirements of a software system to support the conduction of a systematic review. The abstractions of the protocol model (chapter 3.3) can be used to design a software system and the use cases of the protocol model (chapter 4) can be considered as requirements for such a system.

The research done prior to the development of the model was focused on executing systematic reviews in a business context. Specifics for systematic reviews in a business context are, for example, the search area, which may include more than academic databases, and the dissemination, which may be through different channels and in different forms than systematic reviews in other domains. While reviewing the literature, it became clear that most existing guidelines were developed to facilitate systematic reviews in the medical context. Combining different guidelines and identifying the semantic aspects, enabled the creation of a model that is applicable for executing systematic reviews in all domains. Due to the simplification and generalization of the protocol model, the specifics for systematic reviews in a business context were not taken into account. Due to the systematic approach of systematic reviews, as well as the flexibility of the model, the model may be used in all domains. In order to determine if this assumption is valid, the model should be tested with sample data from systematic reviews in other domains.

6. Conclusions & Recommendations

This report addressed the problem identifying the minimum steps of a systematic review, regardless of its research domain and the possibility of modelling a protocol for a systematic review. The steps were identified through a literature review and modelled as a goal model, followed by the design of an executable protocol model. Domain-specific and optional steps were excluded from the model, to capture the core of systematic reviews and develop a model that is applicable in all domains.

The protocol model was tested with two reviews within two different research domains; research and requirements engineering. The requirements for a support system were identified as use cases. The model also identifies the minimum components of a systematic review, which are covered by the model and reflected as actors, objects, attributes, transitions, behaviours and events. Equivalents of the minimum components presented in the model, can be found in all guidelines that were reviewed as part of the literature review. Therefore, a systematic review can generically be defined as review method with a systematic approach that includes predefined eligibility criteria, data extraction methods and a form of collecting key points.

The most beneficial results of using the model are the following:

- The model serves as an audit log of the review, which allows the full review to be replicated.
- The model ensures that the essential elements of a systematic review are included; search details are recorded, a dashboard is created to allow the construction of a flow diagram, the main research question is answered and recommendations for future research and practical implications are captured.
- The model helps to prevent defects in the review, as explained in chapter 5.

6.1. Recommendations for practice

The developed protocol model may be used as a reference system and audit log when undertaking systematic reviews, by researchers in any domain. The use of the model ensures that the author uses a logical sequence of preparing, conducting and reporting the review and records the most important components of the review, to be able to create a review report upon.

Furthermore, the model may be further developed, maintained or adapted to a specific domain, by means of the ExtREME methodology that was described in the research. Changes to the model may be initiated with new goals, requirements or concepts.

6.2. Recommendations for further research

The model may be extended with the parts that were considered outside of the scope of this research; creating the final report and disseminating the review. In order to create a report, each component of the report should be covered, such as the rationale, the introduction, a thematic analysis, a descriptive analysis and limitations. Furthermore, more Java callbacks may be included in order to validate steps in the process. A Java callback could, for example, block a user to continue to the next step if an attribute is left blank or automatically complete the review when all required attributes are completed.

In addition, further development and testing may be conducted by means of the ExtREME methodology which has also shortly been mentioned in the previous section. The methodology may be used to improve a model by practitioners, as well as by researchers.

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Appendix 1 – Model SRSS

```
MODEL SRSS

OBJECT Review

      NAME Review Name

      ATTRIBUTES
      Review Name: String,
      Main Research Question: String,
      Time of Publication Start: Date,
      Time of Publication End: Date,
      Conclusion: String,
      Recommendations for Future Research: String,
      Practical Implications: String,

      STATES
      In Preparation,
      In Review,
      In Search,
      In Reporting,
      Completed,

      TRANSITIONS @new*Create Review =In Preparation,

                        In Preparation*Add Main Research Question =In
Preparation,
                        In Preparation*Add Sub Research Question =In
Preparation,
                        In Preparation*Add Publication Period =In
Preparation,
                        In Preparation*Add Eligibility Criteria =In
Preparation,
                        In Preparation*Preparation Completed =In Review,


                        In Review*Execute Search =In Search,
                        In Search*Add Document =In Search,

                        In Search*Search Completed =In Review,


                        In Review*Create Dashboard =In Reporting,

                        In Reporting*Answer Sub Research Question =In
Reporting,
                        In Reporting*Answer Main Research Question =In
Reporting,
                        In Reporting*Add Recommendations for Future
Research =In Reporting,
                        In Reporting*Add Practical Implications =In
Reporting,

                        In Reporting*Review Completed =Completed,

OBJECT SubResearchQuestion
            NAME Sub Research Question
            ATTRIBUTES Sub Research Question: String,Relevance to Main
Research Question: String,Answer: String,Review:Review,
            STATES Added,Answered,
```

```
            TRANSITIONS @new*Add Sub Research Question =Added,
                              Added*Add Key Point =Added,
                              Added*Answer Sub Research Question =Answered,

OBJECT EligibilityCriteria
            NAME Eligibility Criteria
            ATTRIBUTES Eligibility Criteria: String,Include:
Boolean,Review:Review,
            STATES Added,
            TRANSITIONS @new*Add Eligibility Criteria =Added,

OBJECT Search
            NAME Database
            ATTRIBUTES Database: String,Search String: String,Executed on:
Date,Review:Review,
            STATES Executed,Completed,
            TRANSITIONS @new*Execute Search =Executed,
                              Executed*Add Document =Executed,
                              Executed*Search Completed =Completed,

OBJECT Document
            NAME Document Title
            INCLUDES DuplicateCheck
            ATTRIBUTES Document Title: String,Reference Details:
String,Reason for Exclusion: String, Research Method:String,Review:Review,
            STATES Found,Abstract Included,FullText Included,Method
Included,Abstract Excluded,FullText Excluded,Method Excluded,
            TRANSITIONS @new*Add Document =Found,
                              Found*Abstract Exclude =Abstract Excluded,
                              Found*Abstract Include =Abstract Included,
                              Abstract Included*FullText Exclude =FullText
Excluded,
                              Abstract Included*FullText Include =FullText
Included,
                              FullText Included*Method Exclude =Method
Excluded,
                              FullText Included*Method Include =Method
Included,
                              Method Included*Add Key Point =Method
Included,

BEHAVIOUR !DuplicateCheck
            STATES Unique, Duplicate
                        TRANSITIONS @any*Add Document =Unique,

OBJECT KeyPoint
            NAME Key Point
            ATTRIBUTES Key Point: String,Document:
Document,SubResearchQuestion:SubResearchQuestion,
            STATES Found,
            TRANSITIONS @new*Add Key Point =Found,

OBJECT Dashboard
            NAME Dashboard Name
            ATTRIBUTES Dashboard Name: String,Review:Review,
            !NumberOfHits: Integer,
            !NumberOfExcludedBasedOnAbstract: Integer,
            !NumberOfExcludedBasedOnFullText: Integer,
            !NumberOfExcludedBasedOnMethod: Integer,
            !FinalNumberOfIncluded: Integer,
            STATES Created
```

```
            TRANSITIONS @new*Create Dashboard =Created,

EVENT Create Review
      ATTRIBUTES Review:Review,Review Name: String,
EVENT Add Main Research Question
      ATTRIBUTES Review:Review,Main Research Question: String,
EVENT Add Sub Research Question
      ATTRIBUTES Review:Review,SubResearchQuestion:SubResearchQuestion,Sub
Research Question: String,Relevance to Main Research Question: String,
EVENT Add Publication Period
      ATTRIBUTES Review:Review,Time of Publication Start: Date,Time of
Publication End: Date,
EVENT Add Eligibility Criteria
      ATTRIBUTES Review:Review,EligibilityCriteria:EligibilityCriteria,
Eligibility Criteria: String, Include: Boolean,
EVENT Preparation Completed
      ATTRIBUTES Review:Review,
EVENT Execute Search
      ATTRIBUTES Review:Review,Search:Search,Database: String,Search
String: String,Executed on: Date,
EVENT Add Document
      ATTRIBUTES Review:Review,Search:Search,Document:Document,Document
Title: String,Reference Details: String,
EVENT Abstract Exclude
      ATTRIBUTES Document:Document,
EVENT Abstract Include
      ATTRIBUTES Document:Document,
EVENT FullText Exclude
      ATTRIBUTES Document:Document,Reason for Exclusion: String,
EVENT FullText Include
      ATTRIBUTES Document:Document,
EVENT Method Exclude
      ATTRIBUTES Document:Document,Research Method: String,Reason for
Exclusion: String,
EVENT Method Include
      ATTRIBUTES Document:Document,Research Method: String,
EVENT Add Key Point
      ATTRIBUTES SubResearchQuestion:SubResearchQuestion,
Document:Document, KeyPoint:KeyPoint,Key Point: String,
EVENT Search Completed
      ATTRIBUTES Review:Review,Search:Search,
EVENT Create Dashboard
      ATTRIBUTES Dashboard Name: String, Dashboard: Dashboard,
Review:Review,
EVENT Answer Sub Research Question
      ATTRIBUTES Review:Review,SubResearchQuestion:SubResearchQuestion,
Answer: String,
EVENT Answer Main Research Question
      ATTRIBUTES Review:Review, Conclusion: String,
EVENT Add Recommendations for Future Research
      ATTRIBUTES Review:Review, Recommendations for Future Research:
String,
EVENT Add Practical Implications
      ATTRIBUTES Review:Review, Practical Implications: String,
EVENT Review Completed
      ATTRIBUTES Review:Review,

#-----------------------------------------------------
ACTOR Organizer
      BEHAVIOURS Review, SubResearchQuestion, EligibilityCriteria
```

```
      EVENTS  Create Review, Add Main Research Question, Add Sub Research
Question, Add Publication Period, Add Eligibility Criteria, Preparation
Completed,
ACTOR Reviewer
      BEHAVIOURS Review, Search, SubResearchQuestion, Document, KeyPoint,
Dashboard
      EVENTS  Execute Search, Add Document, Abstract Exclude, Abstract
Include, FullText Exclude, FullText Include, Method Exclude, Method
Include, Add Key Point, Search Completed, Create Dashboard, Answer Sub
Research Question, Answer Main Research Question, Add Recommendations for
Future Research, Add Practical Implications, Review Completed
```

Appendix 2 – Dashboard Callback

```
package SRSS;

import com.metamaxim.modelscope.callbacks.*;
import java.util.*;

public class Dashboard extends Behaviour {

//Number of Hits
public int  getNumberOfHits() {
            int NumberOfHits=0;

            Instance[] Hit =
this.getInstance("Review").selectByRef("Document", "Review");
            for (int i = 0; i < Hit.length; i++)
            {
                  NumberOfHits+=1;
                  }
              return NumberOfHits;
              }

//Number of Excluded Based on Abstract
public int  getNumberOfExcludedBasedOnAbstract() {
            int NumberOfExcludedBasedOnAbstract=0;

            Instance[] Hit =
this.getInstance("Review").selectByRef("Document", "Review");
            for (int i = 0; i < Hit.length; i++)
            {
              String documentState = Hit[i].getState("Document");
              if (documentState.equals("Abstract Excluded"))
                  NumberOfExcludedBasedOnAbstract+=1;
                  }
              return NumberOfExcludedBasedOnAbstract;
              }

//Number of Excluded Based on FullText
public int  getNumberOfExcludedBasedOnFullText() {
            int NumberOfExcludedBasedOnFullText=0;

            Instance[] Hit =
this.getInstance("Review").selectByRef("Document", "Review");
            for (int i = 0; i < Hit.length; i++)
            {
              String documentState = Hit[i].getState("Document");
              if (documentState.equals("FullText Excluded"))

                  NumberOfExcludedBasedOnFullText+=1;
                  }
              return NumberOfExcludedBasedOnFullText;
              }

//Number of Excluded Based on Method
public int  getNumberOfExcludedBasedOnMethod() {
            int NumberOfExcludedBasedOnMethod=0;

            Instance[] Hit =
this.getInstance("Review").selectByRef("Document", "Review");
            for (int i = 0; i < Hit.length; i++)
            {
```

```
              String documentState = Hit[i].getState("Document");
              if (documentState.equals("Method Excluded"))
                  NumberOfExcludedBasedOnMethod+=1;
                  }
              return NumberOfExcludedBasedOnMethod;
              }

//Final Number of Included
public int  getFinalNumberOfIncluded() {
            int FinalNumberOfIncluded=0;

            Instance[] Hit =
this.getInstance("Review").selectByRef("Document", "Review");
            for (int i = 0; i < Hit.length; i++)
            {
              String documentState = Hit[i].getState("Document");
              if (documentState.equals("Method Included"))
                  FinalNumberOfIncluded+=1;
                  }
              return FinalNumberOfIncluded;
              }

            }
```

Appendix 3 – DuplicateCheck Callback

```
package SRSS;

import com.metamaxim.modelscope.callbacks.*;
import java.util.*;

public class DuplicateCheck extends Behaviour {

      public String getState() {
            String myDName=getString("Document Title");
            Instance[] existingDS = this.selectInState("Document", "@any");
            for (int i = 0; i < existingDS.length; i++)
               if (existingDS[i].getString("Document
Title").equals(myDName) &&
                   !existingDS[i].equals(this))
                        return "Duplicate";
            return "Unique";

      }
      }
```