

## Chapter 2

# Scientific Positioning and Research Approach

*Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house.*

– Henri Poincaré  
French Mathematician (★1854 – †1912)

Researching information systems in organisations is a complex undertaking, involving people, organisational structures, and technologies.<sup>40</sup> Furthermore, the research of IT security is, as initially stated, often times lacking adequate research designs when addressing research topics.<sup>41</sup> Therefore, it is necessary to embed the design of viable IT (security) artefacts<sup>42</sup> for solving relevant organisational problems in research frameworks, in order to address them in an adequate way.<sup>43</sup>

Accordingly, this chapter is dedicated to the scientific positioning (Sect. 2.1) and the hence ensuing research approach (Sect. 2.2) being used for designing and researching the artefact(s) of this thesis. Finally, the mapping of the relevant papers, which were written for this thesis, to the research approach is presented in Sect. 2.3.

### 2.1 Scientific Positioning

To substantiate the research approach of this thesis, the first step is dedicated to the discussion of the scientific positioning. This is important, as the scientific positioning affects the design of the taken research approach and the choice of

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<sup>40</sup>Hevner et al. (2004, p. 79).

<sup>41</sup>Siponen and Willison conducted a study on the IT security literature between 1990 and 2004 on about 1,000 articles. Siponen and Willison (2010, p. 1556).

<sup>42</sup>For simplification reasons, the term *artefact* will be used synonymously for *IT artefact*.

<sup>43</sup>Becker (2008, p. 8).

		Epistemological Position	
		Objective cognition is impossible.	Objective cognition is possible.
Ontological Position	A real world is existent (Ontological Realism)	<i>Interpretivism</i>	<b>Positivism</b>
	No real world exists (Ontological Constructivism)	<b>Constructivism</b>	

Fig. 2.1 Scientific positioning (Based on Holten et al. (2005, p. 178))

research methods used to carry out research, both affecting the quality of the research.<sup>44</sup> To this regard, the *ontological position* and the *epistemological position* are the two overarching positions to be observed. Their combinations and resulting research positions are further depicted in Fig. 2.1 and in the course of this chapter.

The *ontological position* relates to the questions of: “What can be known?”, “What is?”, “How it is?”,<sup>45</sup> studying the nature of reality itself.<sup>46</sup> The two viewpoints that arise from this question are whether the *world* observed by a researcher actually exists, independent from a subject’s individual perception (*ontological realism*), or if the observed *world* is constructed from subjective influences (*ontological constructivism*).<sup>47</sup> Due to the fact that the research carried out in this thesis assumes a real world, the position of an objectively observable reality is taken (*ontological realism*).

The *epistemological position* refers to the relationship of cognition and the object of cognition itself<sup>48</sup> and therefore to the way how scientific knowledge is acquired and created.<sup>49</sup> To this regard, epistemology explores the nature of knowledge.<sup>50</sup> While for an ontologic constructivist no real world exists (*constructivism*), the question or not the *real world* can be perceived in an objective and unaltered way or not arises for an ontological realist. Here, the epistemological position can be distinguished between the *positivist* and the *interpretivist* paradigm<sup>51</sup>:

<sup>44</sup>Burrell and Morgan (1979, p. 3) and Easterby-Smith et al. (2002, p. 27).  
<sup>45</sup>Becker and Niehaves (2007, p. 202) and Hatch (1997, p. 47).  
<sup>46</sup>Vaishnavi and Kuechler (2008, p. 16).  
<sup>47</sup>Holten et al. (2005, p. 177) and Weber (2004, p. v).  
<sup>48</sup>Holten et al. (2005, p. 177).  
<sup>49</sup>Becker and Niehaves (2007, p. 201) and Hatch (1997, p. 47).  
<sup>50</sup>Vaishnavi and Kuechler (2008, p. 16).  
<sup>51</sup>Cf. Fig. 2.1; Becker and Niehaves (2007, p. 201) and Holten et al. (2005, p. 177).

- The *positivist paradigm* assumes an objective cognition, in which the object of investigation is researched by using objective methods similar to the methods applied in the natural sciences.<sup>52</sup> To this regard, the world exists beyond the researcher's cognition.<sup>53</sup>
- For the *interpretivist paradigm*, however, an objective cognition is not possible, because (in most cases) the cognitive process is influenced or altered by linguistic interactions and/or social and cultural aspects.<sup>54</sup>

Based on the discussion above, this research is positioned in the *interpretive paradigm*,<sup>55</sup> assuming the existing of a “real world” (ontological position) that has a subjective understanding of the social interactions between individuals (epistemological position).<sup>56</sup> This is due to the fact that the collected data<sup>57</sup> and the results of this thesis<sup>58</sup> are interpreted by the researcher. The consequences of this position on the research are further elaborated in the following sections and in Sect. 5.1.<sup>59</sup>

## 2.2 Applied Design-Science Framework

To answer the initially posed research question and to build the relevant artefact(s), a three-step research approach was developed to structure the research carried out in this thesis and to allow other researchers to evaluate the work done here.<sup>60</sup> This research approach follows the principles of the design-science guidelines as described by Hevner et al.<sup>61</sup> and is lined out along the research frameworks presented and discussed by Nunamaker et al.,<sup>62</sup> Peffers et al.,<sup>63</sup> and Vaishnavi and Kuechler.<sup>64</sup>

As a first step, the principles and the guidelines for design-science research are further described in Sect. 2.2.1. Following this, the individual steps of the resulting

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<sup>52</sup>Burrell and Morgan (1979, p. 5), Easterby-Smith et al. (2002, p. 28), and Lee (1999, p. 29).

<sup>53</sup>Weber (2004, p. iv).

<sup>54</sup>Hatch (1997, p. 48) and Easterby-Smith et al. (2002, p. 30).

<sup>55</sup>Dotted box in Fig. 2.1.

<sup>56</sup>Burrell and Morgan (1979).

<sup>57</sup>E.g., expert interviews as described in Sect. 5.2.

<sup>58</sup>Cf. Sect. 5.1.

<sup>59</sup>For the layout of the taken research approach, the ideas laid out by Walsham were taken up in Chap. 5 (Walsham 2006).

<sup>60</sup>To this regard, Peffers et al. refer to *mental models* for research approaches, which help other researchers to understand and evaluate the work of other researchers (Peffers et al. 2008, p. 7).

<sup>61</sup>Hevner et al. (2004, p. 82).

<sup>62</sup>Nunamaker et al. (1991, p. 98).

<sup>63</sup>Peffers et al. (2008).

<sup>64</sup>Vaishnavi and Kuechler (2008, p. 21).



### 2.2.1 Design-Science Principles and Guidelines

Looking into the domain of IS research, two major, complementary research paradigms can be identified – namely these are *behavioural science* and *design-science*.<sup>67</sup>

Behavioural science is mainly concerned with the understanding and prediction of phenomena surrounding artefacts, aiming at the *truth* and the exploration of the validity of cause and effect.<sup>68</sup>

Being well established in European IS research,<sup>69</sup> design-science itself is rooted in engineering and the science of the *artificial*.<sup>70</sup> In contrast to the initially mentioned behavioural science paradigm, the design-science paradigm is concerned with the creation and evaluation of artefacts (see below), focusing on the utility, in creating things that serve “human purpose” and offering solutions to an understood research problem.<sup>71,72</sup> These artefacts can come in the shape of *constructs, models, methods, or instantiations*.<sup>73</sup> However, some debate exists on whether or not other artefact types (e.g., *better theories*, organisational artefacts) can be viable outcomes of design-science research as well.<sup>74</sup> Following the definition of Hevner et al.,<sup>75</sup> the focus of this thesis is laid upon *IT artefacts*, being the core objects of investigation.<sup>76</sup> Table 2.1 summarises and further describes the different types of artefacts, resulting from design-science research.<sup>77</sup>

Furthermore, design-science artefacts are intended to “purposefully” solve problems, which were identified as being relevant for an organisation. This is achieved by defining innovative artefacts as ideas, practices, technical capabilities, etc. rather than fully developed IS used in practice, even though fully developed IS can be the case.<sup>78</sup>

Moreover, various processes on how to do design-science research are discussed in the relevant scientific literature.<sup>79</sup> To this regard, by using a sound design-science

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<sup>67</sup>Hevner et al. (2004, p. 79) and Vaishnavi and Kuechler (2008).

<sup>68</sup>Hevner et al. (2004, p. 79) and Winter (2008, p. 470).

<sup>69</sup>Winter (2008, p. 470)

<sup>70</sup>Hevner et al. (2004, p. 76) and Simon (1996).

<sup>71</sup>Hevner et al. (2004, p. 79), March and Smith (1995, p. 253), Peffers et al. (2008, p. 6), and Winter (2008, p. 470).

<sup>72</sup>Cole et al. also include the theories, which are associated with the artefact itself (Cole et al. 2005, p. 326).

<sup>73</sup>Vaishnavi and Kuechler (2008, p. 13) and March and Smith (1995, p. 256).

<sup>74</sup>Vaishnavi and Kuechler (2008, p. 14) and Winter (2008, p. 471).

<sup>75</sup>Hevner et al. (2004).

<sup>76</sup>Hevner et al. (2004, p. 82).

<sup>77</sup>Cf. March and Smith (1995, p. 256).

<sup>78</sup>Hevner et al. (2004, p. 83).

<sup>79</sup>Examples from the IS research literature include: Hevner et al. (2004), March and Smith (1995), Nunamaker et al. (1991), and Peffers et al. (2008). Furthermore, Peffers et al. identified a greater

**Table 2.1** Artefact outputs of design-science research (Based on Hevner et al. (2004, p. 23), March and Smith (1995, p. 256), and Österle et al. (2010, p. 4))

Artefact type	Description	Example
<i>Constructs:</i>	Provide vocabularies and symbols to define problems and solutions, enabling the construction of models or representations of the problem domain	Arabic numbers, symbols used in Entity-Relationship (ER) models
<i>Models:</i>	Sets of propositions or statements expressing relationships among constructs. Models represent situations as problem-and-solution-statements and can be viewed as a description of "... how things are"	Models built for specific business situations, semantic data models
<i>Methods:</i>	Set of steps (an algorithm) used to perform a task. Based on a set of underlying constructs (language) and representation (model) of the solution space	Systems development methods, design methods
<i>Instantiations:</i>	Realisation of an artefact in its environment by operationalising constructs, models, and methods. Instantiations demonstrate the feasibility and effectiveness of the models and methods they contain, providing a <i>proof</i> of construction (Nunamaker et al. 1991)	Intellectual tools or software tools

cycle, researchers can achieve two major things<sup>80</sup>:

- Firstly, the design-science cycle provides a roadmap for researchers who want to use design as a research mechanism for IS research.<sup>81</sup>
- Secondly, such a research cycle can help researchers by legitimating design-science research, just as other researchers understand the essential elements of empirical IS research. Furthermore, they accept research that is well done using understood and accepted processes/cycles.

For the research presented here, the design-science research cycle presented by Vaishnavi and Kuechler will be used as foundation. The cycle itself can be segregated into five distinct phases<sup>82,83</sup>:

body of IS and other disciplines, regarding commonly used elements for research processes and cycles (Peffers et al. 2008, p. 47).

<sup>80</sup>Peffers et al. (2008).

<sup>81</sup>Peffers et al. state that such a research cycle would not be the only way that design-science research could be done, but it would suggest "a good way to do it" (Peffers et al. 2008).

<sup>82</sup>Adapted from Vaishnavi and Kuechler (2008, p. 20).

<sup>83</sup>The phases of the design-science cycle by Vaishnavi and Kuechler were used for structuring this thesis into four parts (I–VI), mapping the individual chapters to the *Awareness/Suggestion*, the *Development*, *Evaluation*, and *Conclusion* phase.

- **Awareness of Problem:** The first phase refers to the identification of a relevant problem, resulting in a proposal for a new research endeavour, including (implicit/explicit) criteria to evaluate the artefact against.
- **Suggestion:** Following directly, the suggestion phase presents a tentative solution for the problem that is based on the *reconfiguration* of already existing knowledge.
- **Development:** In the next step, the tentative solution is further developed and implemented. To this regard, the novelty does not need to lie in the implementation process itself, but primarily lies in the design of the artefact.
- **Evaluation:** Based on the initially laid out evaluation criteria, the next phase is dedicated to the evaluation of the constructed artefact. Any deviations from these criteria and expectations to the artefact need to be recorded and analysed, resulting in hypotheses about the artefact's behaviour. In case that these hypotheses do not match the expected outcomes, a new iteration and reconceptualisation needs to take place, resulting in a new cycle of the process.
- **Conclusion:** Concluding the design-science cycle, the last phase finalises the research effort once the results of the evaluation are considered to be sufficient according to the previously set research goal. Knowledge acquired in the process can either be final and reproducible or results in subjects for future research projects.

Based on the previous discussions, Hevner et al. established seven guidelines, having the purpose to help researchers, reviewers, etc. to understand the requirements for effective design-science.<sup>84</sup> As advised by the authors, these guidelines should serve as “helpers” rather than mandatory items to be fulfilled by researchers. However, in order to be complete, research should address the guideline in some manner.<sup>85</sup>

Table 2.2 lists the seven design-science guidelines presented by Hevner et al. and gives a short summary of each of them. Furthermore, these guidelines were also used when developing this research approach. Their mapping to the three steps of the taken research approach is visualised in Fig. 2.2, indicated by numbers, which map to the individual guideline.

### 2.2.2 Design-Science Framework

As depicted in the previous chapters, the research approach followed here is based on the design-science paradigm. Initial research approaches to answer the posed research question and sub-questions<sup>86</sup> were already discussed in previous

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<sup>84</sup>Hevner et al. (2004, p. 82).

<sup>85</sup>Hevner et al. (2004, p. 82).

<sup>86</sup>Cf. Sect. 1.3.

**Table 2.2** Design-science research guidelines (Hevner et al. 2004, p. 83)

Guideline	Description
<i>Guideline 1: Design as an artefact</i>	Design-science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation
<i>Guideline 2: Problem relevance</i>	The objective of design-science research is to develop technology-based solutions to important and relevant business problems
<i>Guideline 3: Design evaluation</i>	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods
<i>Guideline 4: Research contributions</i>	Effective design-science research must provide clear and verifiable contributions in the areas of the <i>design artefact</i> , <i>design foundations</i> , and/or <i>design methodologies</i>
<i>Guideline 5: Research rigour</i>	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact
<i>Guideline 6: Design as a search process</i>	The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment
<i>Guideline 7: Communication of research</i>	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences

papers of the author.<sup>87</sup> However, this first outline was constantly revised, in order to accommodate the changing requirements during the actual research process. Following, the three steps of the research approach are detailed and linked to the ensuing chapters of this thesis. This should help to understand the sequence, how this research has been carried out, and which methods were used in the individual steps (*Guideline 5*). Furthermore, the following chapters in this thesis address the details of the used methods, giving more in-depth insights.

2.2.2.1 Step 1: Awareness and Suggestion

The *first step* of the designed research approach deals with the problem identification and the analysis of the problem relevance of the presented research questions.<sup>88</sup> Here the foundations and goals for the further research are laid out and discussed, resulting in the design of the relevant IT artefact(s) for solving the posed research-question(s) in the following steps.<sup>89</sup>



<sup>87</sup>E.g. Royer (2008a, p. 780) and Royer (2008b, p. 405).  
<sup>88</sup>This maps to the phases *Awareness* and *Suggestion* in the design-science cycle presented by (Guideline 2). Vaishnavi and Kuechler (2008).  
<sup>89</sup>Cf. Royer (2008a,b).



### 2.2.2.2 Step 2: Development

The *second step* depicts the actual design process and the creation of the researched artefact(s)<sup>90</sup> (*Guideline 1*). Within this step, the first three sub-questions (SQ 1–3) are discussed.



Sub-question 1<sup>91</sup> is dedicated to the review of the relevant scientific and practitioners literature, in order to screen the available methods for evaluating EIdM and IT security investments in general (assessment of the *state-of-the-art*). For the following steps this helps to identify the available methods and to evaluate their advantages and disadvantages.<sup>92</sup>

Based on the initial literature review, the next sub-question (SQ 2)<sup>93</sup> employs a series of expert interviews for analysing<sup>94</sup> which methods are actually used in real-life, and why certain methods are (not) used. Furthermore, the relevant requirements for a decision support framework and the important aspects and information to be included when analysing EIdMS are explored as well. The targeted experts are practitioners in the field of EIdM (cf. Table 5.1). For the analysis, the qualitative content analysis (QCA) is used. Further details on the applied (interview and analysis) methodology and the results of this step are discussed in Sect. 5.1.

Sub-question 3<sup>95</sup> can be answered by a synthesis of the first two sub-questions (SQ 1 and 2). Therefore, a theoretical model<sup>96</sup> as artefact of this thesis is derived, including its constructs and relations (*Guideline 4*). The search process for the artefact is laid out iteratively (*Guideline 6*), by coupling feedback loops to the first and second sub-question.<sup>97</sup> The derivation of the theoretical model itself is based on the framework by Lee.<sup>98</sup> Lee's approach is followed, as it integrates the subjective and the positivist perspective by interpreting the results of the interviews, in order to derive and validate<sup>99</sup> the model.<sup>100</sup> Further details on the taken approach will be discussed in Chap. 5.

<sup>90</sup>This maps to the *Development* phases in the design-science cycle presented by Vaishnavi and Kuechler (2008).

<sup>91</sup>SQ 1: Which are the methods that can be used to evaluate investments into EIdM?

<sup>92</sup>Cf. Royer and Meints (2009) and Chap. 4.

<sup>93</sup>SQ 2: Which of these methods are applied in practice and what are their shortcomings?

<sup>94</sup>Österle et al. state that expert interviews are a typical research method for the analysis and the exploration phase of design oriented research in the field of *business informatics* (Österle et al. 2010, p. 5).

<sup>95</sup>SQ 3: What is the information about the requirements and properties actually needed to evaluate investments into EIdM, in order to address the shortcomings of existing methods?

<sup>96</sup>Cf. Royer (2010).

<sup>97</sup>E.g., by integrating the results of the expert review described in Sect. 5.4.

<sup>98</sup>Lee (1991).

<sup>99</sup>The formal review of the resulting theoretical model, as depicted in *Guideline 3*, is presented in Sect. 5.4.

<sup>100</sup>See also Royer (2010).

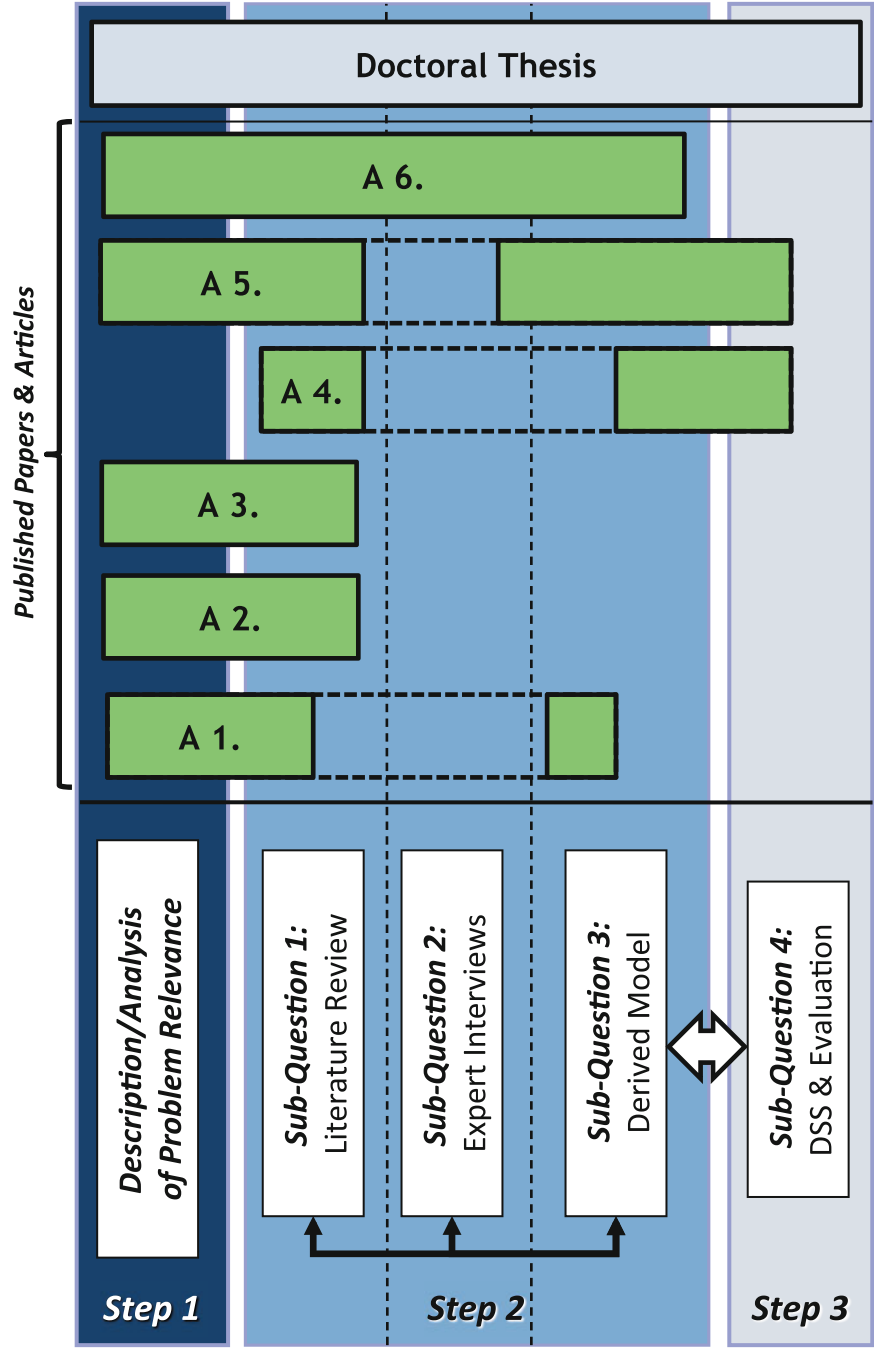


Fig. 2.3 Mapping of the thesis papers to the individual research steps (own representation)

**Table 2.3** Overview of papers being used in this thesis (cf. Annex A for details)

No.	Publication details	Type
A 1.	Royer, Denis (2008): <i>Enterprise Identity Management – What’s in it for Organisations?</i> – IFIP/FIDIS Summer School	Summer school paper
A 2.	Royer, Denis (2008): <i>Assessing the Value of Enterprise Identity Management (EIdM) – Towards a Generic Evaluation Approach.</i> – ARES Conference	Conference paper
A 3.	Royer, Denis (2008): <i>Ganzheitliche Bewertung von Enterprise Identity Management Systemen – Der Ansatz der Balanced Scorecard als taktisches Entscheidungsunterstützungsinstrument.</i> – GI Sicherheit	Conference paper
A 4.	Royer, Denis; Meints, Martin (2008): <i>Planung und Bewertung von Enterprise Identity Managementsystemen.</i> – DuD Zeitschrift	Journal paper
A 5.	Royer, Denis; Meints, Martin (2009): <i>Enterprise Identity Management – Towards a Decision Support Framework based on the Balanced Scorecard Approach.</i> – Wirtschaftsinformatik/BISE	Journal paper
A 6.	Royer, Denis (2010): <i>Supporting Decision Making for Enterprise Identity Management – An Explanatory Model for Describing the relevant Impacts.</i> – 18 <sup>th</sup> ECIS Conference 2010, Pretoria (Republic of South Africa)	Conference paper

### 2.2.2.3 Step 3: Evaluation

In order to evaluate and validate “utility”, “quality”, and “organisational” fit of the designed artefact (design evaluation),<sup>101</sup> the fourth sub-question<sup>102</sup> (*third step*) of the presented research approach depicts an expert interview based empirical evaluation (*Guideline 3*). As a first step, a prototypical decision support system as proof of concept, based on the theoretical model, is described and implemented.<sup>103</sup>



For the artefact evaluation of the design’s utility, a second expert interview series was conducted, which is further described in Chap. 7. Following the sixth guideline (*Guideline 6*), this step is laid out iteratively as well. This way, new results can be integrated into the design process for the artefact.

<sup>101</sup>Becker (2010, p. 16) and Hevner et al. (2004, p. 85).

<sup>102</sup>*SQ 4*: How can the information about the requirements and properties be applied into a decision support instrument/model for the evaluation of EIdM investments (and how can the instrument/model be evaluated)?

<sup>103</sup>See Chap. 6 for further details.

#### 2.2.2.4 Conclusion

The conclusion is the summarising step of the design-science cycle. Here, the results and the artefact(s) for the evaluation of investments into EIdM in organisations are presented. Moreover, further research opportunities are presented, which surface from not yet answered questions.



### 2.3 Mapping of Articles

Concluding this chapter and following *Guideline 7* of the design-science guidelines by Hevner et al. (2004), several scientific publications in journals and at conferences have been written in the past 4 years to present the results to management and technology oriented audiences. Furthermore, these publications can be aligned alongside the three steps and four sub-questions of the research approach.<sup>104</sup> Figure 2.3 and Table 2.3 visualise this mapping of the articles being integrated into this PhD thesis.<sup>105</sup> The bars in Fig. 2.3 indicate the publications and the sub-question they (partly) map to. This document (*Doctoral Thesis* – in grey) combines the individual components, which are further described in the following chapters.

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<sup>104</sup>Cf. Fig. 2.2.

<sup>105</sup>In Table A.1 (Annex A), details of the papers (A 1.–A 6.) are given, including the complete references and the qualification points.



<http://www.springer.com/978-3-642-35039-9>

Enterprise Identity Management  
Towards an Investment Decision Support Approach  
Royer, D.  
2013, XX, 219 p., Hardcover  
ISBN: 978-3-642-35039-9