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TEA - A Technology Evaluation and Adoption Influence Framework for small and medium sized enterprises

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Abstract Emerging technologies compel small and medium sized enterprises (SMEs) to advance their digital transformation. However, a conclusive and applicable overview on influencing factors for the evaluation and adoption of new technologies, on a sensitizing level, is nonexistent. Previous work has focused on adoption frameworks on an implementation level, disregarding the interconnectedness with evaluation and an appropriate application for SMEs. To empower SMEs to develop a transformation strategy considering these influencing factors, the Technology Evaluation and Adoption Influence (TEA) Framework has been designed. It covers nine influence factors operating from the external and internal company environment. To determine the factors, 56 insurance brokers distributed in Switzerland, South Africa and Turkey were interviewed and existing frameworks were analyzed. The design process went through three iterations involving experts for verification and testing. Within a field test with an expert user, the framework proved its conclusiveness, applicability, and significance for SMEs.

Keywords: technology, evaluation and adoption, transformation, digitalization, SME

1 Introduction

Digitalization plays an important role in all industries [4, 7]. Existing business models are being disrupted and IT takes the role of an enabler (if aligned with business) to push digital transformation in all areas of the economy. This transformation is changing the value chain in almost all businesses. Traditional industry boundaries are fading away. The evaluation and adoption of new technologies has thus become critical for business success [4, 7]

While large enterprises have specialized units to manage the challenge of digitalization, small and medium enterprises (SMEs) who are similarly affected by the transformation do not have these specialized functions [3, 6] and often lack adequate knowledge and resources. This is alarming, given their important and dominant role in the economy of many countries worldwide. Empirical evidence supports the importance of SMEs for their contribution towards job creation, productivity, and economic growth in developing and developed countries [36]. All market economy enterprises, irrespective of their legal form and activity, are classified as SMEs if they employ fewer than 250 persons, i. e. have between 1 and 249 employees [23].

It is therefore important that SMEs understand what influences them on their journey of digital transformation. There are several best practices how to evaluate and implement technology [8]. However, most of them are not suitable for SMEs due to their unique characteristics, for example a general shortage on resources. Existing publications do not cover the specific factors influencing SME's evaluation and adoption of technology on a sensitizing level to support strategy development. They rather focus on the adoption of technology on an implementation level. Most existing work disregards the interconnectedness of evaluation and adoption, and as a result does not enable an SME-appropriate application.

For SMEs, the evaluation and adoption process has to be simplified compared to bigger organizations. An approach can consist of three main phases: initial adoption stage, implementation stage, and post adoption stage [8]. According to Lin, Huang and Burn IT investment evaluation methodologies have a direct positive relation to the technology adoption readiness of a company [15]. The aim of this study is to develop a framework for SMEs to foster the awareness of digital transformation. Therefore, we present a framework that merges the two aspects of evaluation and adoption and analyzes influence factors for both aspects interconnectedly. The framework is on the sensitizing level, corresponding to the Animate-phase of the ABILI-method [22]. The ABILI-method helps SMEs in all industries with a pragmatic and company size appropriate approach to tackle the digital transformation. The development of the framework was led by three design science research iterations: a prototyping iteration, a refinement iteration, and in the end a finalizing iteration.

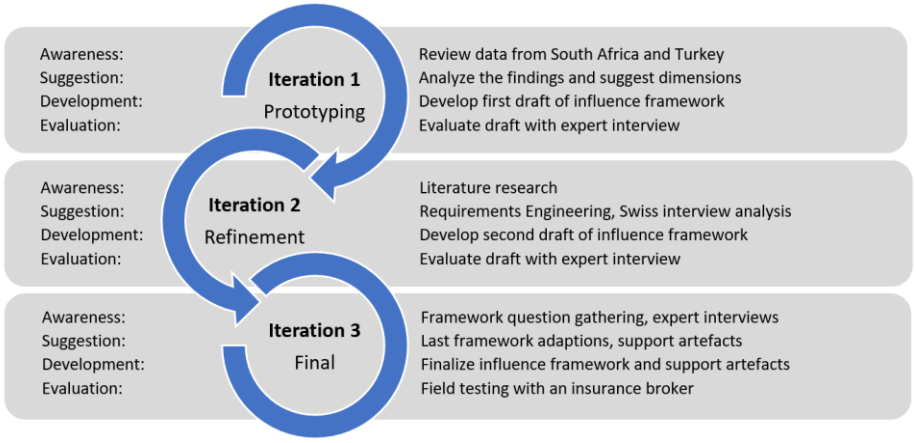
The paper is organized as follows: In Section 2 the research method is presented. In Section 3 the design artefact requirements are formulated. The literature review representing an analysis on existing relevant frameworks is presented in Section 4. In Section 5 the designed artefact with its nine influencing factors is described. The application integration of the artefact is described in Section 6. The paper concludes with a brief summary and an outlook on future research in Section 7.

2 Research Methodology

The research relies on a design science approach. Figure 1 displays an overview of the development phases, which reflect the authors' interpretation of design science research based on a model by Kuechler and Vaishnavi [14]. The research strategy of this paper consists of three iterations. Each iteration added new insights to the framework and therefore several sources of information were used for the development. In the first iteration, interview data from South Africa (15 interviews) and Turkey (25 interviews) built the base for a first framework draft. In the second iteration, a review of existing frameworks, as well as 16 interviews from Switzerland were used. All 56 interviews were semi-structured and had an average duration of 40 minutes. Interviewees were non-randomly, purposively selected convenience sampling. In the third iteration, the evaluation feedback of the latter phase was implemented, and the application designed.

Thereafter, the finalized framework was evaluated in a field test with a manager from an insurance broker company.

Figure 1. Adapted Design Science Research Cycles; own interpretation based on [14]



3 Requirements to the TEA Influence Framework

The requirements summarized in Table 1 were guiding the development of the framework. It is important to define the requirements of an artefact considering user and stakeholder involvement to ensure the expected quality on an artefact, especially if the artifact is developed iteratively [26]. The requirements were engineered within the iterations drawing back on interview data and a literature review.

Table 1. List of the requirements

Requirement	Description
Resource-friendly	If applied, all information needed shall be accessible through SME appropriate methods with a reasonable time effort, as SME resources are in general scarce [8]
Adaptability	All SMEs are having their singularities, thus the designed artefact must be flexible to meet customer needs [23].
Applicability	If applied, it must be easy to use, as this rises the chances of application according to an interviewed industry expert. The user must be led through the process of application with a clear structure and guidelines [22].
Conclusive	All relevant influencing factors across a company's environment shall be included to enable a profound strategy development [22]
Sensitizing	The designed artefact must sensitize the user on the aspects influencing them on their transformation due to the complexity [23].
Simplifying	The designed artefact must simplify the complex environment of influencing factors to enable the user to gain a better understanding of the impacts to the business [8].

4 Related Work on Influence Frameworks

Previous research on technology evaluation and adoption was consulted in order to identify relevant influencing factors, which were then grouped along four categories: external, organizational, technical, and people factors. This categorization was used to analyze the focus, and strength and weaknesses of the theories and frameworks. Not all publications were equally strong in the enclosure and conclusiveness of the categories. Nevertheless, in their totality they provide a diverse view on the influencing factors of technology evaluation and adoption.

Two conspicuousness were detected while reviewing the publications. First, the customer (of an SME) as an influencer on technology adoption is rather scarcely discussed and never takes prominent role in the frameworks or theories. Even though the customer builds a central part in the fields of digitalization and development of new products and services [22]. Second, the application of the frameworks and theories is not defined; they are therefore hard to apply for unspecialized SMEs. In Table 2, a summary of the reviewed publications is given, including a description of the construct nature and the strengths and weaknesses of the frameworks.

Table 2. Summary of frameworks and theories

Authors	Construct Nature	Strength and Weaknesses
Rogers Everett [25]	DOI is a theory about how, why, and at what pace new technology or innovations get adopted in a company	W: does not include the environment context but professional networks S: widespread and recognized model, has been applied and adapted in various ways [20]
Tornatzky & Fleischer [32]	focusing on technological innovation decision making, including technology-organization and environment aspects	W: for more complex and newer technology adoption, additional models are needed to achieve better understanding S: has a solid theoretical basis and is considered as more complete than DOI [20]
Ghobakhloo et al. [8]	Conceptual model of effective IT adoption process within SMEs, focusing on implementation	W: guidelines laid-out for the implementation phase, ignoring the animate phase S: based on profound theory including a conclusive set of influencing dimensions
Al-Mamary et al. [2]	Theoretical framework specifically for MIS (Management Information System) adoption	W: no environmental context S: summarizes all influencing factors in two internal dimensions where everything runs together
Padilla-Vega et al. [21]	Theoretical framework specifically for mobile technology adoption based on technology-organization and environment aspects	W: scarce description of the influencer and how they affect the adoption S: includes an international perspective on the adoption challenges

The comparison of the existing frameworks with the pre-defined requirements revealed two major desiderata: First, a focus on guidance for applying the frameworks is missing. Therefore, the adaptability of the frameworks is either not evaluable or not approved. Second, the existing frameworks lack a sensitizing aspect. Most frameworks do not sensitize the user on aspects of both, evaluation and adoption, but rather focus on the implementation act of the technology.

5 The TEA Influence Framework

The Framework has two dimensions, the external and internal environment, containing influencing factors, which are described using influence categories. Figure 2 illustrates the TEA Influence Framework (Technology Evaluation and Adoption Influence Framework). The green fields represent the external environment of an organization with its four influencing factors: Government, competitive field, partner and customer, and consultant and vendor. The yellow fields on the other hand, represent the internal environment of a company such as the IT landscape, resources, IT knowledge, used practices, and culture. In this chapter we elaborate the several fields of our framework giving examples form the insurance broker industry.

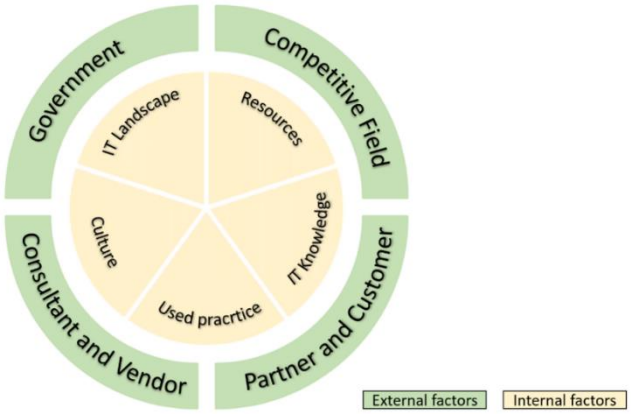


Figure 2. TEA Influence Framework

5.1 The External Environment

Government

There is a significant positive relationship between government support and IT adoption [8]. SMEs generally depend more on external resources and support than bigger companies, due to their limiting size [23]. Government regulations, according to the interviews, should not only focus data security regulations but especially on official **industry standards** for interfaces between the several parties, enabling developing

new solutions and interconnecting their systems. The awareness of **subsidy** programs for ICT adoptions reduces the perceived cost barrier within SMEs and therefore fosters their digitalization [27]. Even if the government offers subsidy programs, SMEs are not always aware of their existence. Swiss brokers see tax savings from IT investments as a driver (and form of subsidy) for technology evaluation and adoption. Government policies also affect the **infrastructure** companies are using. Examples are electricity and access to efficient broadband as well as projects such as the development of 5G networks in Switzerland.

Competitive Field
According to [23], competitive pressure is rather a small driver for SMEs to foster digital transformation. Nevertheless, the competitive field has its impact on the choice and usage of new technologies and therefore on the innovation strategy of a firm [35]. Direct **competitors** are for many firms a pressure point to keep up with the technological change and providing a means to survival, growth, and competitive advantage [8]. This was also clearly identified in the interviews; industry standards in the broker industry such as IG B2B from Switzerland influence the technology adoption. The competitive field does not only consist of market competitors such as other insurance brokers, but also of **technology startups**. The **technology market trends** as an environmental influencer of technology adoption are clearly recognized by the TOE framework [20, 32]. These trends, with a focus on economical, industrial, and social factors, are also considered in the Panoramic Lens, one of the tools in the Animate-phase of the ABILI-method [10]. The output from Panoramic Lens is used as an input for this framework (for details see Section 6).

Partner and Customer
The influencer "partner and customer" in terms of technology evaluation and adoption is not considered in the analyzed frameworks [2, 8, 21, 25, 32]. Nevertheless, the Swiss insurance brokers as well as the experts consider this factor as vital, as insurance brokers act as intermediaries between insurance company (partner) and end consumer (customer) and must cover different needs. Regarding partners, the framework mainly refers to **insurance companies** and to the **professional network** of a SME. Partners in many cases "dictate" which technology must be implemented. Professional networks have a positive impact on technology adoption as they provide access to key contacts and support, as well as novel and valuable information also regarding the possible success of innovation projects [25]. Furthermore, **customer** needs are central in the choice of technology and a customer base analysis on the readiness of new technologies is useful and meaningful.

Consultants and Vendor
The technology characteristics of **IT products** available in the market are significant determinants in the evaluation and adoption process of SMEs [9]. The interviews have clearly shown that SMEs outsource the technology evaluation. The professional abilities of **consultants** as well as **vendors** have a positive impact on the technology evaluation and adoption, as SMEs lack on internal IT expertise [2, 5]. Therefore, access to

quality IT-expertise is crucial for the innovativeness of SMEs [29]. The information quality (availability, understandability, and accuracy) and complexity (features, usability, reliability, and flexibility) of a new IT product determine the technology acceptance as well as future readiness of a company [2, 19, 21, 30, 32]. Additionally, the technology acceptance is influenced by the **licensing structure** since this structure is often not accurate enough for smaller companies.

5.2 The Internal Environment

IT landscape
Several studies over several decades have indicated that the **business and IT alignment** is a universal problem in companies [16]. The business needs and goals must be met by the new technology to improve business processes and the overall business value of the firm. Therefore, if considering a new system, it must be insured that the **technology-fit** is perceived consistent and matches with the current IT landscape, business goals and processes [21]. Most technology-fit models are based on the four elements from Henderson & Venkatraman [11] (business strategy, IT strategy, organizational infrastructure, and IT infrastructure) that need to be aligned [16]. The current IT landscape is determined by what **hardware** and **software** tools are already implemented in an organization. According to some of the Swiss interview participants, the current infrastructure tends to be a limiting influence factor on the choice of technologies, as industry standards for matching interfaces are missing. A major challenge for companies is therefore to understand the effects of new technology on the existing IT landscape with its implemented hardware and software [1].

Resources
SMEs in general suffer from a limited access to particular resources, such as money, time, staff, and company size,which distinguishes them from lager companies [8, 25, 32]. **Financial** resources are the key performance requirements and are critical success factors for SMEs based on the resource based theory [24]. According to Madrid-Guijarro et.al., financially constraint companies are less likely to invest in new technology [17]. Most of the interview participants judge the financial slack. The perceived cost-benefit ratio of a new technology becomes a major influencing factor. The evaluation process itself is highly influenced by the shortcoming on **time** within the interview participants' companies. IT product variety is perceived as huge and participants do not have time for a profound screening, as the **staff** evaluating, and consulting customers can be the same due to the **company size**. In addition to a shortcoming on staff there is a lack in specialization (especially in IT), as mostly generalists are employed and wanted in SMEs.

IT knowledge
Resistance to change has a direct link to IT knowledge within the SMEs and the prerequisites for making optimum use of new technologies are the introduction and **training** of employees to the new technologies and the development of **IT skills** [2, 8, 23]. A company and its employees must adapt to the new technologies so that they can be

integrated into the products, services, corporate culture, and strategy in order to achieve positive benefits. IT skills as well as experience and training do affect the attitude of staff towards new technologies and therefore influence technology acceptance or its evaluation and adoption process. There is often a lack on IT knowledge in SMEs [8]. A better understanding and higher expertise on technology encourages organizational members in participation, however it may make it more difficult to achieve consensus [25]. Sufficient training on a new system and on IT skills in general increases the **computer self-efficacy** of the firm's employees. Self-efficacy refers to the belief of the employees that they have the skills to manage a certain task successfully [2, 34]. Summarizing, the more IT-knowledge in a company, the lower the risks of IT adoption [31].

Used practices

The interviews and the literature research show that there is a lack on **structured approaches** to evaluate new technologies. Structured tools and guidelines are rarely used and a standardized process for evaluation and adoption is usually not implemented. **User involvement** or participation is a major influencer on the technology acceptance and therefore on the success of such a project [8]. The **communication** process within a SME including the interconnectedness of the employees (means how well they are linked among each other) is crucial for a successful IT acquisition [25, 32]. In an environment of constant change, internal communication processes play an important role in improving the work environment and hinder instability and uncertainty among the companies employees [18].

Culture

The corporate culture affects the evaluation, adoption, and usage of ICTs; thus, SMEs should start investigating their cultures, analyzing how they are expressed, and describe the culture [33]. The interviews have shown that the **decision** culture of a SME is influenced by top **management** [8]. This centralization of technology acquisition decisions negatively affect the innovativeness of a company [25]. Top management and its courteous support and openness on a new technology or system also effects the perceived usefulness and user satisfaction of the employees [2]. However, IT-related projects usually enjoy insufficient attention by management, which is considered as one of the main problems in the computing area of small firms [5]. The culture of **failure** (trial and error on technology experiments) was mentioned by some of the interview participants as an influencer on technology evaluation and adoption. Especially the evaluation and selection phase can involve a long trial and error period [13]. However, only the minority of the SMEs do have a trial and error culture for technology experiments as these projects are expensive and SMEs usually suffer a scarcity of resources [8]. Sosna et. al. emphasizes the importance of trial-and-error learning for businesses aiming towards digital transformation [28].

Change management is a big challenge for a technology implementation and is helpful to respect actions that foster technology acceptance among employees, such as user involvement in the evaluation and adoption process. Some of the interview participants mentioned a **generation issue** within the insurance broker industry, meaning that young people (millennials) do not see this business as attractive anymore. As older

generations have a less familiar relationship to technology compared to the millennials, this becomes an influencing problem [12].

6 Application

The application of the TEA-Influence Framework is based on the Question Catalogue and the Workshop Templates. The question catalogue consists of a range of questions structured along the influence factors and the corresponding influencing categories. A number of sources support the answering of the questions. The workshop templates offer application advice as well as structure the documentation of the workshop on a clear and pragmatic one-pager (see for example Figure 3).

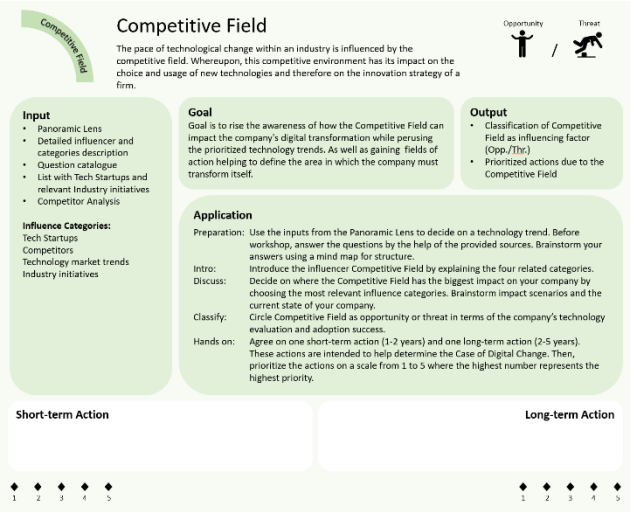


Figure 3. Competitive Field guideline template

The TEA Influence Framework supports the Animate-phase of the ABILI Methodology developed at the FHNW. The ABILI-method merges several digital transformation methods into a sequence of five phases [22]. In the first phase, the Animate Phase SMEs are being sensitized and prepared. The Panoramic Lens is the main Tool for the prioritization of the trends in the environment of SMEs. The output of the Animate Phase is a case of digital change that helps the management to define the digital transformation strategy [22]. The TEA Influence Framework takes the trends from the Panoramic Lens and delivers input for the case of digital change [22]. Through the TEA Influence Framework, SMEs become aware of the influencers affecting them while pursuing the prioritized technology trend. Furthermore, they gain fields of action helping to define the area in which the company must transform. **Error! Reference source not found.Error! Reference source not found.** illustrates the three phases of the application of the TEA Influence Framework. The preparation involves the output of the Pan-

oramic Lens. The highest prioritized technology trend is recommended for the workshop preparations based on the TEA Influence Framework question catalogue. The last

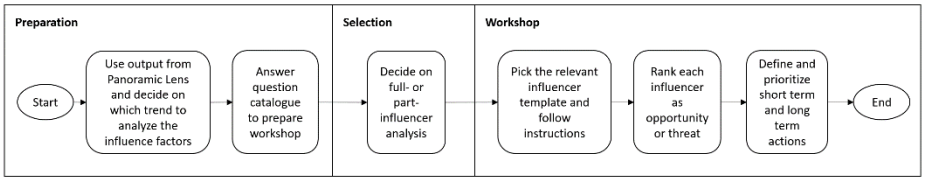


Figure 4. Working with the TEA Influence Framework

stage is the workshop according a guideline template from Figure 3. The next two steps are group discussions involving IT as well as business management.

7 Conclusion

This paper addressed the various challenges of digitalization, which especially affect SMEs as their size and limited resources are obstructions towards the company's digital transformation [3, 22]. Within three design science research iterations, based on 56 interviews and a literature review, an artefact – the TEA Influence Framework – was developed. It provides a conclusive overview on influencing factors for evaluation and adoption of new technologies on a sensitizing level, that was missing so far. This paper therefore contributes to the successful mastering of the digital transformation of SMEs.

This work does not provide step-by-step evaluation and adoption guidelines, as the framework is designed for use in the first phase of the digital transformation, which is dedicated to the preparation and animation of the transformation [22]. The framework is applicable within the Animate-phase of the ABILI-method in correspondence with the Panoramic Lens [10]. Future research may build on this research for further developments and a seamless interplay of the tools within the Animate-phase of the ABILI-method.

Furthermore, the TEA Influence Framework is designed to be applied as a tool in a workshop to create a case of digital change (output of the Animate-phase). However, the framework application in its current state is paper-based and not digitalized nor automated. In further research, the framework might be used to develop a digital tool (Surface-hub application) that supports the case of a digital change workshop in real time. Based on the proposed influencing factors of this paper, the future tool might be able to capture upcoming opportunities or threats of a potential technology in real time. The data gathered while applying the TEA Influence Framework can be used to develop a benchmark tool. According to an industry expert, who evaluated the TEA Influence Framework in iteration two, the user of such a tool is especially interested in comparing the own influencers with other companies in the market to assess the own maturity.

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