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Understanding the determinants of business intelligence system adoption stages: an empirical study of SMEs

Borut Puklavec, Tiago Oliveira, Aleš Popovič,

# Understanding the Determinants of Business Intelligence System Adoption Stages: An Empirical Study of SMEs

## Abstract

Although business intelligence systems (BIS) adoption research has progressed considerably since its early inceptions, our understanding of the influence of BIS determinants across different adoption stages remains limited. In response, we develop and empirically test a conceptual model for assessing the determinants of BIS diffusion on the evaluation, adoption, and use stages. The model is based on two prominent, firm-level adoption concepts: the diffusion of innovation (DOI) and the technology, organization, environment (TOE) framework, extended with our previous research findings. Drawing on data from 181 small and medium enterprises (SMEs), we identify seven distinct determinants (i.e. *cost, BIS is part of ERP, management support, rational decision-making culture, project champion, organizational data environment, organizational readiness*) as statistically significant for different adoption stages.

## Keywords

Business intelligence systems (BIS); Information technology/information systems (IT/IS) adoption; Technology-organization-environment (TOE) framework; Diffusion of innovations (DOI) theory; Adoption stages; Small and medium enterprises (SMEs)

## 1. Introduction

Today's firms generally operate in a complex and extensively competitive global business environment. Such conditions force firms to set goals that include continuously competing with rivals by operating more efficiently and productively, and by reducing operating costs (Chan and Chong, 2013). The widely recognized primary driver of organizational productivity, i.e. technological innovation, will significant contribute to firms' goals, but only when widely adopted (Zhu et al., 2006a). Thus, it is crucial for firms to understand the process and determinants of technology adoption (Karahanna et al., 1999).

One innovation that can significantly contribute to the firm's goals by improving decision-making is business intelligence systems (BIS) (Popovi• et al., 2012). BIS were developed as an IS innovation for offering data integration and analytical capabilities that can provide valuable decision-making information for stakeholders at different organizational levels (Turban et al., 2010, Yeoh and Popovi•, 2016). We define BIS as 'quality information in well-designed data stores, coupled with software tools that provide users timely access, effective analysis and intuitive presentation of the right information, enabling them to take the right actions or make the right decision' (Popovi• et al., 2012). In investigating business value of BIS, existing studies suggest BIS enable enhancements in firms' strategic planning, business processes, improvements of performance, and building of competitive advantage (Popovi• et al., 2014, Davenport et al., 2010, Negash and Gray, 2008) whereas time savings and better information for supporting decision making are considered the main direct benefits of BIS implementation (Watson et al., 2002).

Although there are similarities among different types of IS, prior BIS research reveals key differences between BIS and other types of IS (Popovi• et al., 2012). These divergences are one of the main reasons for the need to examine the field of BIS adoption separately from traditional IS adoption and to gain a better understanding of the determinants and their effects on the BIS adoption process. To do so, firms must consider an integrative view of the adoption process that builds on prior IS adoption studies and advances them to address the specifics of BIS.

In the broader field of IS/IT adoption research, studies about BIS adoption are still scarce. Moreover, extant research in the BIS milieu primarily focuses on large-sized firms (Popovi• et al., 2012, Wixom and Watson, 2010, Yeoh et al., 2008). Accordingly, in the present work we focus on BIS adoption in small and medium enterprises (SMEs). These organizational entities have been found to importantly contribute to a country's economic development, technological advancement, and job creation opportunities (Ayyagari et al., 2011, Fink, 1998).

Further, our work aims to explain the process of BIS adoption at the firm level, as opposed to the more abundant research performed on IT acceptance at the individual level (i.e. acceptance of innovations from individuals within the firm). To the best of our knowledge, this topical area of firm-level IT adoption is still under-researched. We contribute to the existing body of knowledge by answering the call by Puklavec et al. (2014) to identify and empirically test which determinants are important for BIS adoption in SMEs at the firm level.

The remainder of the paper is organized as following: the next section introduces the innovation diffusion theory. Next, we present our research model and hypotheses, outline the data sources and explain our data analysis procedure. This is followed by our findings on the key determinants of BIS adoption at the firm level in SMEs. In the discussion section, we explore the theoretical contributions and practical implications of our findings. Finally, some inherent limitations and avenues for future research are given.



## 2. Theoretical development

### 2.1 Business intelligence systems

Following a longer period of investments in setting up a technological foundation that supports business processes and strengthens the efficiency of operational structure, most firms have reached a point where the utilization of IT to support strategic decision-making became critical (Petrini and Pozzebon, 2009, Popovi• et al., 2014). Perceived as a response to the growing needs for access to relevant information BIS have the potential to maximize use of information, thereby creating or enhancing competitive advantage (Popovi• et al., 2014). From the perspective of firm knowledge creation and through utilitarian view on IS BIS differentiate themselves from other IS 1) through the authority to commence problem articulation and discussion, and 2) on data selection, by addressing various information needs of decision-makers at different organizational levels (Ferrari, 2011, Shollo and Galliers, 2013). Such BIS capabilities play a strategic role for the firms, where the decision-making process is considered a critical success factor as it is by strategic management (Rossignoli et al., 2010).

### 2.2 Technology adoption

In the last decades, different prominent theories, frameworks, and models have shaped the field of technology adoption, e.g. the Technology Acceptance Model

(TAM) (Davis, 1989, Davis et al., 1989), Theory of Planned Behavior (TPB) (Ajzen, 1991), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), Diffusion of Innovation (DOI) (Rogers, 1995) and the Technology, Organization and Environment (TOE) framework (Tornatzky and Fleischer, 1990). Of those listed above, only the DOI theory and TOE framework represent the most prominent adoption models on the firm level (Oliveira and Martins, 2011) and are, as such, commonly employed as theoretical foundations for other firm-level studies and theories (Chong et al., 2009). When addressing a particular technology adoption environment, it is important to combine different adoption models and relevant concepts to achieve a more exhaustive insight into the adoption phenomenon (Oliveira and Martins, 2011). Deriving from the TOE framework and developed in the setting of IT adoption in SMEs, the Iacovou et al. (1995) model represents a good example of upgrading a prominent theoretical foundation for the purpose of a specific research context.

### 2.3 The technology-organization-environment framework (TOE)

The TOE framework encompasses three contexts that influence a firm's adoption of innovation: technology, organization, and environment (Feldman et al., 2016, Tornatzky and Fleischer, 1990). The technology context consists of the availability and characteristics of technology. It refers to all technologies relevant to the firm (internal or external). Next, the organization context denotes the firm's characteristics, such as formal and informal linking structures, communication processes, size, and slack. Finally, the environment context relates to the opportunities for and limitations of innovations, including the industry characteristics and market structure, technology support infrastructure, government regulation, and other actors' endeavors that may have an influence on the adoption (Tornatzky and Fleischer, 1990, Ahmadi et al., 2017, Lin, 2014).

The TOE framework has been viewed as aligned with other explanations of innovation adoption rather than offering a competing explanation to them. Tension between the TOE framework and other theories has been seen as slight, and this tension has, at this point, to be resolved by allowing the TOE framework to subsume competing ideas, rather than respond to them. For instance, it has been noted that the TOE framework is consistent with the theory of the diffusion of innovations (DOI) (Rogers, 1995).

### 2.4 Diffusion of innovations (DOI) theory

DOI theory (Rogers, 1995) explains the diffusion of innovation within a firm. It states that an innovation goes through a five-stage process until it thrives in the firm (Sharma, 2009). The distinction between the different stages of the adoption process allows a better insight into the diffusion of innovations, and offers a possibility to more broadly examine the innovation adoption phenomenon. Although the DOI theory presents five stages, most studies on innovation diffusion focus on only three [i.e. evaluation (persuasion stage), adoption (decision stage), and use (implementation stage)] (Chong and Chan, 2012, Zhu et al., 2006b).

According to the innovation diffusion literature, the assimilation of an innovation starts from a firm's evaluation of the innovation. This initial stage deals with the identification and prioritization of needs and problems on one hand, and with searching the organization's environment to locate innovations of potential usefulness to meet the organization's problems (Rogers, 1995). The degree to which an innovation fits the problem to be solved will influence the decision to adopt the innovation. The IT literature (Armstrong and Sambamurthy, 1999) suggests that the potential of IT to enhance a firm's performance in value chain activities (Porter and Advantage, 1985) is a significant motivation for the firm to adopt IT. Applying this view to BIS context, we define BIS evaluation as assessing the potential benefits of BIS to improve a firm's performance in value chain activities such as cost reduction and market expansion.

Following evaluation is the stage of adoption. Consistent with the technology adoption literature (Rogers, 1995), we define BIS adoption as making the decision to use the BIS for value chain activities. A number of studies examined antecedents of IT adoption decisions and found significant differences between adopters and nonadopters in terms of internal resources and external environments (Iacovou et al., 1995, Zhu et al., 2003). Because the adoption decision legitimizes resource allocation required by the general deployment of the innovation (Cooper and Zmud, 1990), this stage is deemed a necessary step toward the widespread usage of the technology.

Nevertheless, adoption does not always result in widespread usage of the technology by a firm. Assimilation theories suggest that most information technologies exhibit a "gap," i.e., their widespread usage tends to lag behind their adoption (Fichman and Kemerer, 1999). After a new IT innovation is adopted, it needs to be accepted, adapted, and used in the firm (Zhu et al., 2006b). This stream of research has an important implication for our present study: adoption and use are two distinct stages. With BIS use we understand the stage in which BIS is widely used as an integral part in a firm's value chain activities and where its use helps attain the goals for using the system (Burton-Jones and Grange, 2012).

# 3. Research model

We propose an integrative research model (shown in Figure 1) that encompasses the two described prominent, firm-level innovation adoption models, namely the TOE framework and the DOI model, updated with recent findings from the literature (Puklavec et al., 2014). Coupling the TOE framework with the DOI model variables provides an improved ability to explain IT adoption (Hsu et al., 2006, Picoto et al., 2014) and creates a theoretically grounded basis to evaluate the technology, organization, and environment characteristics of an SME that affect BIS adoption. We identify constructs based on existing IT/IS research and augment them with findings from comprehensive exploratory research about the determinants of BIS adoption in SMEs (Puklavec et al., 2014).

In order to gain a deeper insight into the dynamics of the BIS adoption process, we extend the model with BIS evaluation, adoption, and use as dependent variables. These variables are in line with the DOI stages of innovation and certain previous adoption studies (e.g. Bose and Luo, 2011, Chan and Chong, 2013, Chong and Chan, 2012, Thomas et al., 2015, Zhu et al., 2006b) that propose use of the TOE/DOI constructs when studying these three stages of innovation adoption.

## 3.1 The technological context

We consider *relative advantage* as the degree to which a BIS is perceived as being superior to the system it replaces (Rogers, 1995). Earlier studies (e.g. Li et al., 2011, Oliveira et al., 2014, Premkumar and Roberts, 1999, Ramamurthy et al., 2008, Thong, 1999, Tsai et al., 2010) suggest that the relative advantage of an IT innovation is one of the predictors most frequently used in IS adoption research. Positive perceptions of an IS's benefits should induce an SME to adopt the new IT innovation (Thong, 1999). A positive impact should already be indicated in the evaluation phase as firms require confirmation about the project's feasibility and substantive benefits from the IT innovation before its adoption is considered (Ramamurthy et al., 2008), which corresponds to the work of Tsai et al. (2010) where relative advantage significantly impacts the adoption intention. The influence of relative advantage also remains present in late adoption stages since perceived relative advantage positively affects firms' intention to continue to use the innovation (Li et al., 2011). Accordingly, we put forward the following hypothesis:

*Hypothesis 1 (H1): Relative advantage has a positive impact on BIS evaluation, adoption, and use.*

Previous studies argued the financial/cost aspect of an innovation through diverse approaches (Caldeira and Ward, 2002, Chwelos et al., 2001, Hameed et al., 2012, Lee and Larsen, 2009, Lee and Kozar, 2008). We understand *cost* as cost effectiveness, i.e. where the benefits of adoption new technology exceed the costs of such technology (Premkumar and Roberts, 1999). Although cost is no longer a bottleneck for SMEs in adopting an IT innovation due to progress in IT development, the accessibility of out-of-the-box solutions and falling software and hardware prices, the cost aspect remains a big deterrent to adoption (Premkumar and Roberts, 1999). Further, cost is recognized as one of the most significant determinants hindering the IT development of small firms (Iacovou et al., 1995). It is thus common for firms to evaluate the costs relative to the benefits before deciding to adopt an IT innovation (Premkumar and Roberts, 1999). For subsequent adoption stages, namely the adoption and use stages, it is confirmed that costs have a strong effect on both stages (Chong and Chan, 2012). This may be attributed to the importance firms give to reducing costs and, thus, to their readiness to exploit the new IT to reduce costs (Tung and Rieck, 2005). An alternative explanation might be that firms seek a long-term return on their IT investment as opposed to only considering the short-term costs (Chong and Chan, 2012). As a result, we postulate that:

*Hypothesis 2 (H2): Cost (effectiveness) has a positive impact on BIS evaluation, adoption, and use.*

*BIS is part of ERP* is a determinant that has only recently been considered in BIS adoption studies (Puklavec et al., 2014) and holds important value for understanding the BIS adoption phenomenon. We define this determinant as a state where BIS does not subsist as an independent IS solution, but is integrated into an ERP solution as an indivisible part of it and is, as such, typically implemented along with ERP. Yeoh et al. (2008) find that solid data source systems are fundamental for implementing BIS, in ETL (extraction, transformation, loading) processes, and in providing useful information for enhanced decision support. Subsequently, it is crucial to assess the stability and consistency of data source systems in order to avoid the costs stemming from changes after implementation of the BIS (Yeoh et al., 2008). As SMEs generally lack resources (Ifinedo, 2011, Quaddus and Hofmeyer, 2007) and cannot afford extra post-implementation costs, it is even more vital to ensure an adequate data source and smooth ETL, which can be realized with an integrated BIS/ERP solution in which the data source is commonly bound with the BIS, while ETL is ensured natively. Aligning these findings with previous research (Puklavec et al., 2014) where it is suggested that a BIS which forms part of the firm's ERP system will be adopted more often, quicker, and more easily than other BIS, and given that these circumstances are primarily the case of the early adoption stages (i.e. evaluation and adoption stages), we hypothesize that:

*Hypothesis 3 (H3): BIS being part of ERP has a positive impact on BIS evaluation, adoption, and use, yet the effect is greater on the evaluation and adoption stages than on the use stage.*

### 3.2 The organizational context

We consider *management support* as top management's explicit and active support for the introduction and development of an IT innovation (Bruque-Camara et al., 2004). In SMEs, the decision-makers are commonly members of the top management team and, hence, the adoption of an IT innovation should have their explicit and active support (Premkumar and Roberts, 1999). As indicated in various research studies, management support is positively related to the adoption of an IT innovation (Chong et al., 2009, Hameed et al., 2012, Tung and Rieck, 2005). What is more, some previous studies suggest that management support is a key determinant affecting IT adoption (Hwang et al., 2004, Ramamurthy et al., 2008, Tsai et al., 2010) as management's commitment ensures indispensable resources for implementing the new technology (Premkumar and Roberts, 1999). Past research also empirically supports the proposition that management support is crucial to the successful adoption and use of innovations in SMEs since managers act as change agents in the adoption process (Ifinedo, 2011). If management is not convinced about an IT innovation, the innovation will likely not be adopted (Premkumar and Roberts, 1999). Regarding the different adoption process stages, Chan and Chong (2013) reveal that management support is a significant determinant in all three stages of IT innovation adoption. Therefore, we propose that:

*Hypothesis 4 (H4): Management support has a positive impact on BIS evaluation, adoption, and use.*

A *rational decision-making culture* indicates the presence of organization-wide respect for measuring, testing, and evaluating quantitative evidence in decision processes. Such a culture encourages the use of data and information to support work processes and perform analyses, also with advanced techniques (Kulkarni et al., 2017). Previous research suggests that organizational culture signifies an important positive effect on the adoption process of an IT innovation (Gu et al., 2012). Regarding the influence of organizational culture on the use of an innovation, Popovi• et al. (2012) study the strong impact of fact-based decision-making culture on BIS use, while Frambach and Schillewaert (2002) find that in the adoption process's evaluation stage, firms become aware of an IT innovation, form an approach to it, and evaluate it, thus we assume a positive role of firms' rational decision-making culture in the evaluation stage. Based on the discussion, the following hypothesis is put forward:

*Hypothesis 5 (H5): A rational decision-making culture has a positive impact on BIS evaluation, adoption, and use.*

We define *project champion* as a management-level individual who recognizes the usefulness of an idea for the organization, and leads authority and resources for such an idea throughout its development and implementation phases (Meyer, 2000). This individual is the person who creates the awareness and a positive impression of an IT innovation (Gu et al., 2012). The adoption of an IT innovation normally meets certain resistance, and the project champion is expected to reduce such resistance (Hwang et al., 2004). Existing research indicates the presence of a project champion is a significant variable in successful adoption of an IS, and that it impacts all adoption process stages (Bose and Luo, 2011). In the evaluation stage, the project champion conventionally motivates management to acquire an IT innovation and creates awareness of the innovation within the organization. In the later stages of adoption and use, the project champion facilitates user acceptance (Hameed et al., 2012). Consequently, the absence of a project champion can lead to an IT innovation not being adopted, as shown in numerous studies (Hwang et al., 2004). It can thus be hypothesized that:

*Hypothesis 6 (H6): The presence of a project champion has a positive impact on on BIS evaluation, adoption, and use.*

In the existing research, *organizational data environment* is considered as data quality, availability, loading etc., related to the process of preparing input data for BIS (Rehman and Raza Ali, 2014). It is contingent on successful realization of data resource management which can offer several benefits (e.g. reducing errors, increasing the ability to access previously unavailable information and interpret/share data across IT applications) (Ramamurthy et al., 2008). An inadequately managed data environment is linked to problems with data availability, quality, reliability, integrity, security, and data standards (Ramamurthy et al., 2008). An environment with such characteristics can face serious challenges when seeking to introduce and adopt BIS because BIS depend highly on the integration of different data sources (Popovi• et al., 2010). We therefore propose that:

*Hypothesis 7 (H7): A high quality organizational data environment has a positive impact on BIS evaluation, adoption, and use.*

We consider *organizational readiness* as the availability of the organizational resources required for innovation adoption (Iacovou et al., 1995). In this study, we discuss this determinant using the availability of financial, technological, and other necessary resources, aside from IT knowledge and expertise in the adopting organization (Grandon and Pearson, 2004, Ifinedo, 2011). While some previous research suggests organizational readiness is not significant (Ifinedo, 2011, Grandon and Pearson, 2004, Quaddus and Hofmeyer, 2007), other studies confirmed this determinant as a significant (Mehrtens et al., 2001, Tsai et al., 2010) or even the most significant factor (Hameed et al., 2012) in adoption of an IT innovation. Consistent with Iacovou et al. (1995), organizational readiness could be one of the primary aspects explaining the BIS adoption behavior of SMEs, not only in the adoption but also in the evaluation stage as better prepared firms are usually less likely to feel intimidated by the new IT innovation and further in the use stage since firms which can afford better BIS projects are more likely to experience greater benefits from use of the BIS. We thus suggest that:

*Hypothesis 8 (H8): Organizational readiness has a positive impact on BIS evaluation, adoption, and use.*

### 3.3 The environmental context

Specific to the environmental context, we consider external support as relevant to BIS adoption. *External support* refers to the readiness of support for implementing and using a technology-based solution (Premkumar and Roberts, 1999, Quaddus and Hofmeyer, 2007). Outsourcing and third-party support are shown to have an important impact on the adoption of IT innovations as firms are more prepared for the risks of implementing new technologies if adequate vendor or third-party support for the technology is available (Premkumar and Roberts, 1999). Moreover, the more external support is expected, the more SMEs are motivated to adopt IT innovations since SMEs have a limited number of internal IT experts available to support implementation; this lack of experts is also recognized as a major inhibitor of advanced IS adoption in SMEs (Lee and Larsen, 2009). As seen in the definition of external support, this determinant not only influences the adoption but also the use of the innovation. When adding in Lee and Larsen's (2009) assertion that external support significantly affects the evaluation and actual adoption, it can be postulated that:

*Hypothesis 9 (H9): External support has a positive impact on BIS evaluation, adoption, and use.*

### 3.4 Technology adoption stages

According to the DOI theory (Rogers, 1995), an IT innovation adoption process goes through various stages. While these stages might be viewed as individual independent variables in an adoption model, their interdependence should also be considered (Sharma, 2009, Saeed and Abdinnour, 2013).

Evaluation of BIS arises when the firm initiates a consideration of the different aspects (technology, organization, environment) of the BIS adoption process. In the evaluation phase, the firm collects information about the BIS, which is then used for evaluating the BIS's suitability and possible advantages it may bring to the firm and its users (Zhu et al., 2003). The evaluation stage constitutes the foundation for an efficient adoption. Thus, we posit:

*Hypothesis 10 (H10): The evaluation of BIS has a positive impact on BIS adoption.*

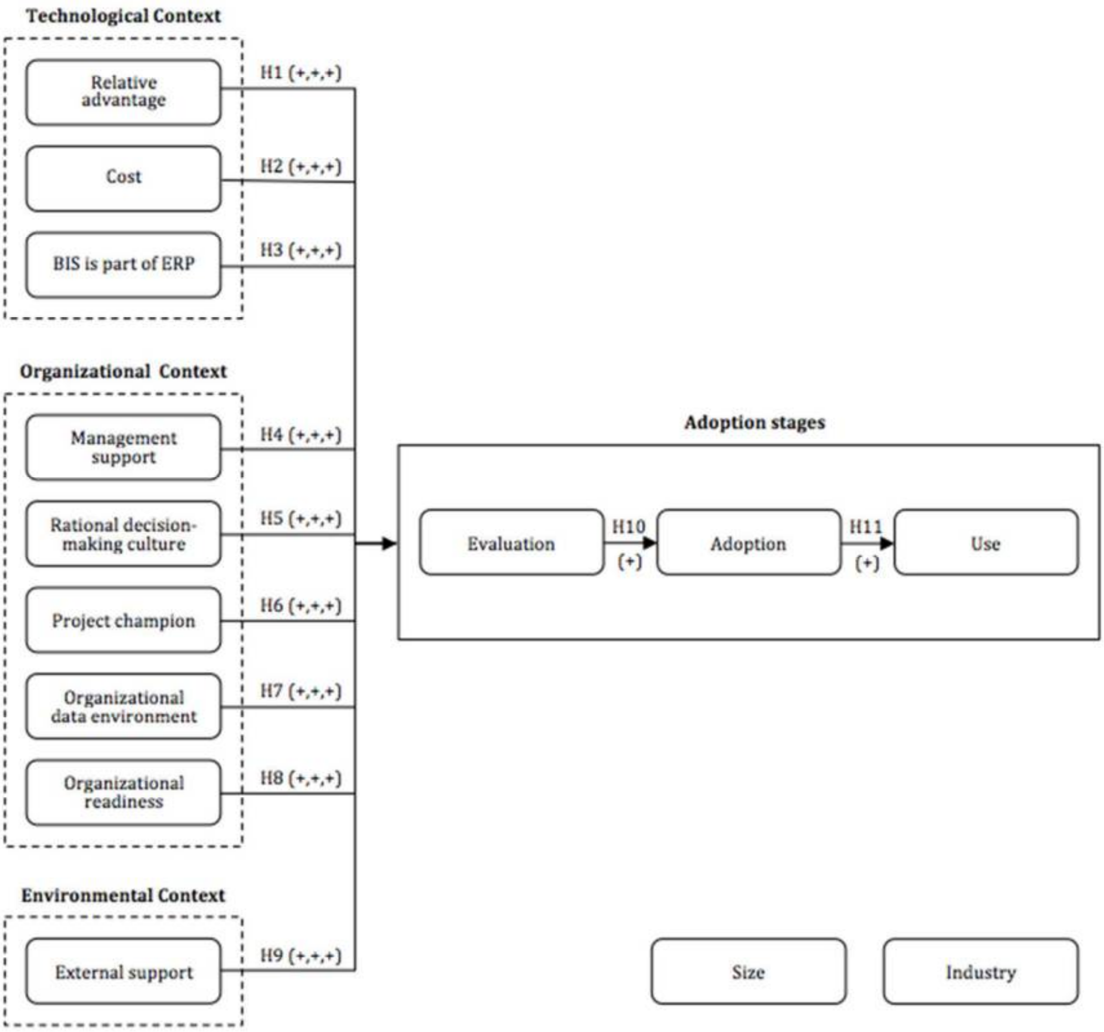
The adoption phase refers to the decision-making when a firm chooses which BIS solution suits its requirements (Chong and Chan, 2012). Following previous research, we propose a systemic sequence among the adoption stages, whereby BIS adoption leads to the BIS use stage (Chan and Chong, 2013). With BIS use we understand using a BIS in a way that helps attain the goals for using the system (Burton-Jones and Grange, 2012). Accordingly, we hypothesize:

*Hypothesis 11 (H11): BIS adoption has a positive impact on BIS use.*

### 3.5 Controls

*Size* and *industry* variables are used to control data variation that is not explained by the other variables of the proposed model. After considering earlier studies (Buonanno et al., 2005, Gu et al., 2012, Hsu et al., 2006, Popovi• et al., 2014, Thomas et al., 2015, Thong, 1999), we include size and industry dummy variables as control variables.

*Figure 1: Research model*




# 4. Research methodology

## 4.1 Measurement

Based on the proposed conceptual model, we develop a questionnaire to conduct a survey within SMEs. The questionnaire covers the following constructs: relative advantage (RA), cost (C), BIS is part of ERP (BPE), management support (MS), rational decision-making culture (RDMC), project champion (PC), organizational data environment (OCE), organizational readiness (OR), external support (ES), evaluation (E), adoption (A), and use (U). These constructs were based on the existing literature (Hameed et al., 2012, Puklavec et al., 2014, Iacovou et al., 1995, Oliveira et al., 2014, Rogers, 1995, Tornatzky and Fleischer, 1990). The measurements applied a seven-point Likert scale on an interval level ranging from “strongly disagree” to “strongly agree”. Consistently with the respective literature, all constructs used were operationalized as reflective, except the use that was operationalized as formative construct.

Questionnaire items were reviewed for their content validity by a group of six IS researchers and BI professionals, all aptly familiar with the BIS adoption phenomenon in SMEs. Following their comments, some amendments to the questionnaire instrument were made. The instrument was further pilot tested on 25 randomly selected SMEs from the sample frame, which confirmed its validity and reliability.

### 4.2 Data

We used an online survey service which allows online surveys to be created, executed, and briefly analyzed. To obtain a comprehensive list of survey respondents, namely firms that qualify for small or medium-sized firms according to the official country classification, we merged records from the commercial business register with records of business entities from the database of the National Agency for Public Legal Records and Related Services. The final list provided 2,024 SMEs from various industry sectors eligible for inclusion in the study. The invitation to complete the survey was distributed by email. In order to increase the content validity, participation of the most qualified BIS person (i.e. CIO, other management, or senior IS personnel) was requested, along with a brief yet complete description of the research's scope and importance. Once the participant firm agreed to participate in the study, a second email was sent to the participating individuals explaining the nature of the research and asking additional information about the participant. Each individual provided additional data about his position, year of employment, and experience in the field.

Data were collected in mid-2015. Over 12 weeks, a total of 181 usable responses was obtained, corresponding to a response rate of 8.9%. The relatively low response rate was expected since we had targeted all SMEs, i.e. adopters and non-adopters, regardless of how familiar an individual firm was with BIS. The industry profile of the sample is as follows: 50.3% of the respondents come from the services sector, 24.3% from the manufacturing industry, and 25.4% from the distribution sector.

In order to test for non-response bias, we compare the distributions of early and late respondents in the sample using the Kolmogorov-Smirnov test (Ryans, 1974). The sample distributions of the early and late respondents do not differ statistically (the p-value for all variables was above 0.10). The absence of non-response bias is thus confirmed (Ryans, 1974). Moreover, we test for common method bias using Harman's single-factor test (Podsakoff et al., 2003). The test shows that the most variance explained by a single factor was 24.9% and that none of the factors' variance exceeds 50% of the suggested threshold value. Accordingly, we confirm the absence of any significant common method bias in the data set.

# 5. Results

The data analysis is conducted through partial least squares (PLS), a variance-based structural equation modeling technique. PLS is suitable for this research since: (i) some items in the data are not distributed normally ($p < 0.01$ based on the Kolmogorov-Smirnov test), (ii) the conceptual model is considered as complex; and (iii) it has not been previously tested (C. Martins, Oliveira, & Popovi•, 2014). To test the proposed research model, we use Smart PLS 3 (Ringle et al., 2015).

Before testing the structural model, we first examine the reflective part of the measurement model in order to assess the construct and indicator reliability, internal consistency, convergent validity, and discriminant validity. The quality of the formative construct in the measurement model is then determined through content validity (Straub et al., 2004), multicollinearity (Diamantopoulos and Siguaw, 2006), and weights (Chin, 1998), all described in the following sections.

## 5.1 Measurement model

Examination of the model is reported in Tables 1 and 2. First, we assess the construct reliability, tested using the composite reliability coefficient and Cronbach's alpha. As shown in Table 2, all constructs have composite reliability (CR) and Cronbach's alphas (CA) above 0.7, suggesting the constructs are reliable (Chau, 1999, Straub, 1989).

Indicator reliability is assessed using the criterion that the factor loadings should exceed the value of 0.7 (Henseler et al., 2009). As seen in Table 1 (in bold), all loadings are above 0.7. Further, all items are statistically significant at 0.001. The model thus shows adequate indicator reliability.

In order to test convergent validity, we use average variance extracted (AVE). As seen in Table 2, all constructs show an AVE higher than 0.5, thereby meeting the criterion that the AVE should be above 0.5 so that the construct explains more than half of the variance of its indicators (Henseler et al., 2009, Bagozzi and Yi, 1988).

Discriminant validity is evaluated based on the Fornell-Larcker criterion, cross-loadings, and Heterotrait-Monotrait Ratio (HTMT). The Fornell-Larcker criterion calls for the square root of the AVE to be greater than the correlations between the latent variables (Fornell and Larcker, 1981). Table 2 shows that the square roots of the AVEs (in bold) are greater than the correlation between each pair of variables. The criterion of cross-loadings suggests the loading of each factor should be greater than all cross-loadings (Götz et al., 2010). To achieve these criteria, we delete items ODE4 and E2. Subsequently, as shown in Table 1, the patterns of the loadings are greater than the cross-loadings. Accordingly, both criteria are fulfilled. Finally, we analyzed the HTMT that is lower than 0.82 (results available by author request) that is lower than the recommend threshold of 0.9 (Henseler et al., 2015) (see Table 3).

A condition for evaluating the content validity, describing the degree to which the measured results stand for the content-semantic part of the construct, is an exact content definition for the constructs (Eckhardt et al., 2009). In order to ensure the content validity, our constructs were discussed with several BI professionals from the field, all appropriately familiar with the BIS adoption phenomenon in SMEs, and also decision-makers with adequate knowledge about BIS adoption within the firm to reliably discuss the subject (Churchill, 1979).

For the formative measure use, which is modeled using eight formative indicators, the test for multicollinearity denotes that analysis of significance of outer weights could be conducted as the next step since the variance inflation factor (VIF) values for all indicators are below 5, thus collinearity does not cause an issue (Hair et al., 2013).

Outer weights of the use construct are significant for three indicators; for the other five indicators the outer loading is greater than 0.5 and thus no indicator is eliminated (Hair et al., 2013).

Since the evaluations of construct reliability, indicator reliability, convergent validity, discriminant validity (reflective measures), and content validity, multicollinearity, and weights (formative measures) are adequate, we confirm the constructs are suitable testing the conceptual model.

*Table 1. Loadings and cross-loadings*

| Constructs | Item | RA | C | BPE | MS | RDMC | PC | ODE | OR | ES | E | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Relative advantage (RA) | RA1 | **0.886** | 0.591 | 0.350 | 0.461 | 0.442 | 0.544 | 0.398 | 0.477 | 0.398 | 0.440 | 0.326 |
| | RA2 | **0.924** | 0.602 | 0.344 | 0.471 | 0.501 | 0.553 | 0.431 | 0.531 | 0.429 | 0.442 | 0.417 |
| | RA3 | **0.953** | 0.605 | 0.326 | 0.458 | 0.495 | 0.553 | 0.379 | 0.523 | 0.418 | 0.435 | 0.403 |
| | RA4 | **0.912** | 0.644 | 0.336 | 0.458 | 0.514 | 0.570 | 0.426 | 0.510 | 0.425 | 0.456 | 0.405 |
| | RA5 | **0.859** | 0.634 | 0.290 | 0.448 | 0.498 | 0.545 | 0.398 | 0.455 | 0.427 | 0.399 | 0.416 |
| Cost (C) | C1 | 0.631 | **0.902** | 0.383 | 0.538 | 0.474 | 0.552 | 0.495 | 0.470 | 0.455 | 0.464 | 0.326 |
| | C2 | 0.614 | **0.949** | 0.399 | 0.490 | 0.462 | 0.558 | 0.456 | 0.456 | 0.446 | 0.435 | 0.317 |
| | C3 | 0.641 | **0.932** | 0.432 | 0.463 | 0.475 | 0.537 | 0.402 | 0.453 | 0.460 | 0.451 | 0.331 |
| BIS is part of ERP (BPE) | BPE1 | 0.366 | 0.457 | **0.942** | 0.439 | 0.367 | 0.376 | 0.399 | 0.423 | 0.432 | 0.413 | 0.448 |
| | BPE2 | 0.340 | 0.402 | **0.960** | 0.486 | 0.367 | 0.427 | 0.396 | 0.425 | 0.378 | 0.478 | 0.495 |
| | BPE3 | 0.322 | 0.377 | **0.929** | 0.411 | 0.324 | 0.335 | 0.376 | 0.379 | 0.374 | 0.431 | 0.404 |
| Management support (MS) | MS1 | 0.406 | 0.459 | 0.482 | **0.915** | 0.674 | 0.585 | 0.574 | 0.628 | 0.524 | 0.595 | 0.494 |
| | MS2 | 0.532 | 0.517 | 0.421 | **0.945** | 0.703 | 0.678 | 0.564 | 0.656 | 0.572 | 0.680 | 0.572 |
| | MS3 | 0.459 | 0.511 | 0.417 | **0.915** | 0.647 | 0.648 | 0.538 | 0.638 | 0.488 | 0.710 | 0.506 |
| Rational decision-making culture (RDMC) | RDMC1 | 0.484 | 0.443 | 0.333 | 0.711 | **0.950** | 0.562 | 0.537 | 0.670 | 0.517 | 0.550 | 0.462 |
| | RDMC2 | 0.502 | 0.470 | 0.384 | 0.706 | **0.954** | 0.529 | 0.513 | 0.641 | 0.516 | 0.511 | 0.434 |
| | RDMC3 | 0.538 | 0.490 | 0.348 | 0.671 | **0.936** | 0.533 | 0.522 | 0.614 | 0.480 | 0.486 | 0.415 |
| | RDMC4 | 0.523 | 0.521 | 0.349 | 0.660 | **0.932** | 0.565 | 0.544 | 0.658 | 0.451 | 0.458 | 0.385 |
| Project champion (PC) | PC1 | 0.544 | 0.530 | 0.400 | 0.707 | 0.633 | **0.908** | 0.620 | 0.670 | 0.545 | 0.635 | 0.569 |
| | PC2 | 0.557 | 0.562 | 0.360 | 0.622 | 0.488 | **0.951** | 0.487 | 0.656 | 0.484 | 0.662 | 0.544 |
| | PC3 | 0.612 | 0.574 | 0.376 | 0.612 | 0.508 | **0.950** | 0.510 | 0.616 | 0.494 | 0.663 | 0.583 |
| Organizational data environment (ODE) | ODE1 | 0.468 | 0.471 | 0.416 | 0.604 | 0.537 | 0.594 | **0.941** | 0.654 | 0.542 | 0.497 | 0.420 |
| | ODE2 | 0.407 | 0.462 | 0.319 | 0.529 | 0.542 | 0.546 | **0.917** | 0.620 | 0.429 | 0.452 | 0.357 |
| | ODE3 | 0.348 | 0.405 | 0.403 | 0.523 | 0.462 | 0.429 | **0.901** | 0.558 | 0.429 | 0.430 | 0.290 |
| Organizational readiness (OR) | OR1 | 0.439 | 0.393 | 0.385 | 0.565 | 0.622 | 0.593 | 0.614 | **0.865** | 0.412 | 0.530 | 0.457 |
| | OR2 | 0.509 | 0.449 | 0.431 | 0.702 | 0.639 | 0.669 | 0.695 | **0.899** | 0.510 | 0.616 | 0.508 |
| | OR3 | 0.487 | 0.385 | 0.313 | 0.575 | 0.600 | 0.621 | 0.558 | **0.865** | 0.463 | 0.555 | 0.474 |
| | OR4 | 0.473 | 0.465 | 0.357 | 0.514 | 0.525 | 0.550 | 0.449 | **0.794** | 0.437 | 0.541 | 0.540 |
| | OR5 | 0.415 | 0.402 | 0.342 | 0.556 | 0.503 | 0.478 | 0.488 | **0.799** | 0.383 | 0.587 | 0.484 |
| External support (ES) | ES1 | 0.461 | 0.479 | 0.362 | 0.566 | 0.562 | 0.571 | 0.465 | 0.571 | **0.914** | 0.524 | 0.458 |
| | ES2 | 0.436 | 0.460 | 0.418 | 0.528 | 0.437 | 0.460 | 0.462 | 0.444 | **0.936** | 0.436 | 0.338 |
| | ES3 | 0.357 | 0.390 | 0.366 | 0.460 | 0.410 | 0.436 | 0.480 | 0.396 | **0.889** | 0.405 | 0.332 |
| Evaluation (E) | E1 | 0.429 | 0.435 | 0.452 | 0.662 | 0.494 | 0.640 | 0.486 | 0.620 | 0.498 | **0.918** | 0.559 |
| | E3 | 0.454 | 0.460 | 0.412 | 0.661 | 0.491 | 0.647 | 0.442 | 0.618 | 0.434 | **0.926** | 0.629 |
| Adoption (A) | A1 | 0.423 | 0.313 | 0.476 | 0.548 | 0.442 | 0.585 | 0.368 | 0.568 | 0.383 | 0.620 | **0.966** |
| | A2 | 0.417 | 0.363 | 0.445 | 0.549 | 0.429 | 0.580 | 0.389 | 0.557 | 0.424 | 0.625 | **0.965** |

*Table 2. Descriptive statistics, correlation matrix, and square root of AVEs*

| Constructs | Mean | SD | CR | CA | RA | C | BPE | MS | RDMC | PC | ODE | OR | ES | E | A | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Relative advantage (RA) | 5.769 | 1.254 | 0.959 | 0.946 | **0.907** | | | | | | | | | | | |
| Cost (C) | 5.297 | 1.361 | 0.949 | 0.919 | 0.678 | **0.928** | | | | | | | | | | |
| BIS is part of ERP (BPE) | 4.905 | 2.020 | 0.961 | 0.939 | 0.363 | 0.436 | **0.944** | | | | | | | | | |
| Management support (MS) | 4.916 | 1.623 | 0.947 | 0.916 | 0.506 | 0.537 | 0.474 | **0.925** | | | | | | | | |
| Rational decision-making culture (RDMC) | 5.527 | 1.377 | 0.970 | 0.959 | 0.541 | 0.508 | 0.374 | 0.729 | **0.943** | | | | | | | |
| Project champion (PC) | 5.117 | 1.628 | 0.956 | 0.930 | 0.610 | 0.593 | 0.404 | 0.691 | 0.580 | **0.937** | | | | | | |
| Organizational data environment (ODE) | 5.274 | 1.300 | 0.943 | 0.909 | 0.448 | 0.487 | 0.413 | 0.604 | 0.561 | 0.576 | **0.919** | | | | | |
| Organizational readiness (OR) | 5.373 | 1.321 | 0.926 | 0.899 | 0.551 | 0.496 | 0.434 | 0.693 | 0.685 | 0.691 | 0.667 | **0.845** | | | | |
| External support (ES) | 4.811 | 1.599 | 0.938 | 0.901 | 0.463 | 0.489 | 0.417 | 0.572 | 0.522 | 0.542 | 0.512 | 0.524 | **0.913** | | | |
| Evaluation (E) | 4.810 | 1.640 | 0.919 | 0.824 | 0.479 | 0.486 | 0.468 | 0.717 | 0.534 | 0.697 | 0.503 | 0.671 | 0.504 | **0.922** | | |
| Adoption (A) | 4.092 | 1.565 | 0.965 | 0.927 | 0.435 | 0.350 | 0.477 | 0.568 | 0.451 | 0.604 | 0.392 | 0.583 | 0.418 | 0.645 | **0.965** | |
| Use (U) | 4.799 | 1.813 | NA | NA | 0.490 | 0.416 | 0.497 | 0.682 | 0.535 | 0.660 | 0.569 | 0.613 | 0.502 | 0.650 | 0.673 | **NA** |

*Note*: Composite reliability, Cronbach's alpha, and average variance extracted are not applicable to the formative constructs; CR – composite reliability; CA – Cronbach's alpha; diagonal elements – square root of AVE; off-diagonal elements – correlations

*Table 3. Heterotrait-Monotrait Ratio (HTMT)*

| Constructs | RA | C | BPE | MS | RDMC | PC | ODE | OR | ES | E | A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Relative advantage (RA) | | | | | | | | | | | |
| Cost (C) | 0.727 | | | | | | | | | | |
| BIS is part of ERP (BPE) | 0.386 | 0.470 | | | | | | | | | |
| Management support (MS) | 0.541 | 0.583 | 0.511 | | | | | | | | |
| Rational decision-making culture (RDMC) | 0.569 | 0.543 | 0.394 | 0.777 | | | | | | | |
| Project champion (PC) | 0.650 | 0.641 | 0.430 | 0.746 | 0.614 | | | | | | |
| Organizational data environment (ODE) | 0.478 | 0.530 | 0.446 | 0.659 | 0.598 | 0.619 | | | | | |
| Organizational readiness (OR) | 0.596 | 0.545 | 0.470 | 0.760 | 0.736 | 0.754 | 0.731 | | | | |
| External support (ES) | 0.495 | 0.533 | 0.455 | 0.623 | 0.552 | 0.584 | 0.561 | 0.570 | | | |
| Evaluation (E) | 0.542 | 0.557 | 0.531 | 0.824 | 0.598 | 0.796 | 0.578 | 0.778 | 0.579 | | |
| Adoption (A) | 0.463 | 0.379 | 0.510 | 0.615 | 0.477 | 0.650 | 0.421 | 0.639 | 0.450 | 0.737 | |

## 5.2 Structural model

The predictive capacity of the structural model is evaluated using $R^2$ measures besides the level of significance of the path coefficients. The path significance levels are estimated using the bootstrapping method with 5,000 resamples (Chin, 1998, Henseler et al., 2009). The results of the analysis are summarized in Table 4 regarding direct effects and in Table 5 for the total effects, showing the path coefficients and t-value results. The $R^2$ of dependent variables are respectively 0.63, 0.53, and 0.66 for *evaluation*, *adoption*, and *use*.

*Table 4. Results of the structural model – direct effects*

| Constructs | Evaluation | | Adoption | | Use | |
|---|---|---|---|---|---|---|
| | Path coeff. | t-value | Path coeff. | t-value | Path coeff. | t-value |
| Relative advantage (RA) | 0.005 | 0.062 | 0.112 | 1.385 | 0.095 | 0.969 |
| Cost (C) | -0.002 | 0.029 | -0.181 | 2.357** | -0.117 | 1.567 |
| BIS is part of ERP (BPE) | 0.107 | 1.776* | 0.213 | 2.970*** | 0.117 | 1.625 |
| Management support (MS) | 0.380 | 4.480*** | 0.071 | 0.640 | 0.279 | 2.749*** |
| Rational decision-making culture (RDMC) | -0.122 | 1.790* | -0.021 | 0.234 | -0.027 | 0.279 |
| Project champion (PC) | 0.293 | 3.679*** | 0.239 | 2.276** | 0.161 | 1.614 |
| Organizational data environment (ODE) | -0.077 | 1.088 | -0.103 | 1.182 | 0.202 | 2.465** |
| Organizational readiness (OR) | 0.270 | 3.639*** | 0.186 | 1.732* | -0.058 | 0.508 |
| External support (ES) | 0.047 | 0.756 | 0.021 | 0.288 | 0.023 | 0.288 |
| Evaluation (E) | | | 0.281 | 2.681*** | | |
| Adoption (A) | | | | | 0.311 | 3.702*** |
| | $R^2$ = 63.4% | | $R^2$ = 52.9% | | $R^2$ = 65.6% | |

*Note:* * – significance at p < 0.10; ** – significance at p < 0.05; *** – significance at p < 0.01

Regarding the technological context, the present research finds that the hypothesis that *relative advantage* is a predictor of the BIS adoption (H1) is rejected for all three adoption stages (p > 0.10). The hypothesis of cost as a predictor of BIS adoption (H2) is also rejected for all three adoption stages as we find that *cost* is not statistically significant in explaining BIS *evaluation* and *use* (p > 0.10) and has significant but negative paths to *adoption* (p < 0.05), whereas we proposed a positive relationship between cost and all adoption stages. BIS is part of ERP has significant and positive paths to *evaluation* (p < 0.10) and *adoption* (p < 0.01), but a non-significant and positive path to use (p > 0.10). These results provide partial support for hypothesis 3.

Within the organizational context, *management support* has significant and positive paths to *evaluation* (p < 0.01) and *use* (p < 0.01), yet a non-significant path to *adoption* (p > 0.10), so hypothesis 4 is only partially supported. *Rational decision-making culture* has a significant and negative path to *evaluation* (p < 0.10), and non-significant paths to *adoption* and *use* (p > 0.10). Thus, hypothesis 5 is not supported. The path to *evaluation* (p < 0.01) and *adoption* (p < 0.05) associated with *project champion* is significant and positive, while the path to *use* (p > 0.10) is non-significant and positive, with the outcome that hypothesis 6 is partially supported. *Organizational data environment* has a significant and positive path to *use* (p < 0.05), but non-significant paths to *evaluation* and *adoption* (p > 0.10). Thus hypothesis 7 is also partially supported. Similarly, hypothesis 8 is partially supported as we find that *organizational readiness* has significant and positive paths to *evaluation* ($p < 0.01$) and *adoption* ($p < 0.10$), but a non-significant path to use ($p > 0.10$).

Within the environmental context, all three paths associated with *external support* are non-significant ($p > 0.10$). Thus, hypothesis 9 is not supported. Finally, hypotheses 10 and 11 are both supported since BIS *evaluation* is directly related to BIS *adoption* ($p < 0.01$), and the *adoption* is further related to the *use* ($p < 0.01$).

As direct effects do not always achieve adequate comprehensiveness, in the research we also identify the total effect of independent variables (Lancelot Miltgen et al., 2013). To explain the total effect of an independent variable on *adoption* in a complex research model, the effect of *evaluation* must also be considered, along with the effect of *evaluation* and *adoption*, respectively, when explaining the total effect on *use*. Considering the total effect of independent variables (see Table 5), the hypothesis of *cost* as a predictor of BIS adoption (H2) is still rejected for all three adoption stages, but the path to *use* becomes significant ($p < 0.05$). In contrast, consideration of the total effect provides strong support for hypothesis 3 since in this case *BIS is part of ERP* has significant and positive paths to *evaluation* ($p < 0.10$), *adoption* ($p < 0.01$), and *use* ($p < 0.05$). Correspondingly, in view of the total effect all three paths associated with *project champion* are significant ($p < 0.01$) and positive, providing strong support for hypothesis 6. Examining the total effect of independent variables also slightly changes the partial support for hypothesis (positive path to *adoption* at $p < 0.05$).

*Table 5. Results of the structural model – total effects*

| Constructs | Evaluation | | Adoption | | Use | |
|---|---|---|---|---|---|---|
| | Path coeff. | t-value | Path coeff. | t-value | Path coeff. | t-value |
| Relative advantage (RA) | 0.005 | 0.062 | 0.113 | 1.410 | 0.131 | 1.350 |
| Cost (C) | -0.002 | 0.029 | -0.182 | 2.391** | -0.173 | 2.204** |
| BIS is part of ERP (BPE) | 0.107 | 1.776* | 0.243 | 3.293*** | 0.193 | 2.534** |
| Management support (MS) | 0.380 | 4.480*** | 0.178 | 1.635 | 0.334 | 3.045*** |
| Rational decision-making culture (RDMC) | -0.122 | 1.790* | -0.055 | 0.604 | -0.044 | 0.460 |
| Project champion (PC) | 0.293 | 3.679*** | 0.321 | 3.239*** | 0.261 | 2.647*** |
| Organizational data environment (ODE) | -0.077 | 1.088 | -0.125 | 1.431 | 0.163 | 2.026** |
| Organizational readiness (OR) | 0.270 | 3.639*** | 0.262 | 2.430** | 0.023 | 0.201 |
| External support (ES) | 0.047 | 0.756 | 0.035 | 0.475 | 0.034 | 0.415 |
| Evaluation (E) | | | 0.281 | 2.681*** | 0.087 | 1.937* |
| Adoption (A) | | | | | 0.311 | 3.702*** |

| | | | |
|---|---|---|---|
| | $R^2 = 63.4\%$ | $R^2 = 52.9\%$ | $R^2 = 65.6\%$ |

*Note:* * – significance at $p < 0.10$; ** – significance at $p < 0.05$; *** – significance at $p < 0.01$

# 6. Discussion

Our research makes important contributions to both research and practice and offers implications for the IT/IS literature, in particular for the field of BI and BIS.

## 6.1 Theoretical implications

Our results suggest that, from the perspective of perceived *relative advantage* which BIS can offer firms, BIS are significantly different to other types of IS previously studied. While prior adoption studies generally confirm the perceived relative advantage of an IT innovation as a significant adoption determinant for different IS and various firm sizes, i.e. also for SMEs (Chwelos et al., 2001, Ifinedo, 2011, Oliveira et al., 2014, Tsai et al., 2010, Li et al., 2011), our results indicate that relative advantage is non-significant for BIS adoption. High levels of agreement about the role of relative advantage on one side and the non-significance of this variable on the other suggest that both adopters and non-adopters are well aware of BIS advantages. Thus, BIS can be regarded as an established IT innovation with generally large awareness of its relative advantage. Since non-adopting firms also acknowledge the advantages of BIS, we may assume that their potential adoption of BIS is hindered by other factors.

Next, we find a similar connection for the *cost* variable in the evaluation phase where both adopters and non-adopters consider BIS as being highly cost-efficient, which results in costs being non-significant, thus supporting some previous findings (Lee and Kozar, 2008, Tung and Rieck, 2005). However, in later stages of adoption and use, our results surprisingly contradict most of the previous research (Chong and Chan, 2012, Chwelos et al., 2001, Iacovou et al., 1995) as we find a significant negative effect of cost effectiveness on those stages. One possible explanation is that expectations about BIS cost efficiency are generally overrated. Isolated observation of the adoption or use stage could lead to the incorrect conclusion that higher cost-efficiency hinders BIS adoption or use; when results in these stages are linked with the results of the evaluation phase, it can be concluded that cost is not a significant determinant and that firms are not sensitive to cost efficiency. Further, the negative association likely stems from higher expectations about cost-efficiency in the early phase and decreasing expectations in subsequent phases of the adoption process. As cost effectiveness does not represent a substantial determinant, excessively high expectations at the start of the adoption process do not inhibit further adoption and/or use. But to ensure this, the high expectations must be translated into stable institutions and long-term commitments (Bakker and Budde, 2012).

Contrary to our findings on costs, our results regarding *BIS being part of ERP* suggest that this is one of the most important adoption determinants with an influence all three adoption stages. To understand the roots of the influence of BPE, the features of such an integrated solution should be analyzed through the characteristics of the SME. Integrating BIS with ERP represents a more effective solution in terms of the effort for employees. As SMEs typically have fewer human resources than their larger counterparts, this can importantly impact the adoption (Puklavec et al., 2014). It can thus be expected that reducing the effort for employees should be most effective in late adoption stages as the evaluation phase normally does not considerably affect employees' work routines. Our results support this reasoning. It is also safe to expect that for different adoption stages distinctive features of BPE emerge as being fundamental. Within the evaluation phase, it is expected that considering adopting as an integrated solution (as opposed to separate solutions) will be less disturbing since there is only one adoption endeavor with a single external partner. For this adoption stage, it could also be important that adopting firms are more likely to trust more comprehensive solutions, i.e. solutions that cover a broader range of users' business needs compared to partial solutions where coupling with other partial solutions is needed. All of this continues to be important in the next stage when realization of an anticipated less disturbing adoption takes place. For instance, integrated solutions require a substantially less complicated data preparation and integration process since appropriate tools are normally already pre-prepared and integrated into such a solution; the implementation of BIS does not require analysis of the ERP used etc. In the use stage, influential benefits emerge mostly due to consistent use and support, shared and pre-set settings etc. Hence, users do not need to learn about different systems to achieve their goals.

Next, our research generally confirms extant findings (Chong et al., 2009, Hameed et al., 2012, Ramamurthy et al., 2008, Tsai et al., 2010, Ifinedo, 2011, Hwang et al., 2004) about the prominence of *management support* while adding to the discussion through the detailed analysis of the varying influence of management support across adoption stages. Management support appears as a significant determinant in the evaluation and use stages while it is not significant in the adoption phase. This finding is in line with Thong (1999) where managers' characteristics are recognized as influential for the initial decision to adopt an IS, but subsequently do not influence the extent of adoption. Our findings could be explicated through management's decision-making function; in the evaluation phase, managers must decide whether the firm will carry out the adoption or not. Following its initial prevalence in the evaluation stage, management support holds a diminishing effect in the adoption stage where other determinants gain importance. While this phenomenon was observed by Quaddus and Intrapairot (2001), our study complements this finding: the effect of management support is again amplified in the use stage of the adoption process where management represents one of key users of BIS and also requires other users to use it and provide managers with deliverables (e.g. analyses, reports) to support their decision-making tasks.

To the best of our knowledge, the influence of *RDMC* has not previously been studied in the BIS adoption literature, while some relationship characteristics between RDMC and BIS can be revealed from BIS success studies. While existing literature uncovers rational decision-making culture as a critical factor in ensuring BIS success (Kulkarni et al., 2017, Popovi• et al., 2012), our results reveal that the link between RDMC and BIS success is not comparable with the link between RDMC and BIS adoption. Analyzing the RDMC influence on the adoption and use stages, we find a similar pattern as in the case of perceived relative advantage where adopters and non-adopters are aware of the BIS advantages to a similar extent. In the case of RDMC, adopters and non-adopters find RDMC similarly mature, making the influence of RDMC non-significant for the adoption and use stages. Somewhat different results are found in the evaluation stage, where slightly significant negative impacts of RDMC on the evaluation stage are identified. This initially quite unexpected influence can be explained through the relationship between BIS and RDMC. As BIS represents one of the instruments for instilling and improving RDMC within firms, it is possible that firms with lower levels of RDMC tend to express greater BIS adoption intention than firms which consider that their RDMC is already – without BIS – at higher levels.

Our study results also indicate that *project champion* is the most important factor in the BIS adoption process within SMEs. Thus, our research confirms the findings of previous studies (Bose and Luo, 2011, Chong et al., 2009, Gu et al., 2012, Hwang et al., 2004) and extends them to the BIS context. Further, our study suggests that project champion represents one of the most significant determinants for every adoption stage. Bose and Luo (2011) link the presence of a project champion with the success of any project and, in particular, with projects requiring additional user training and a shift in attitude. The importance of project champion in the use stage, where successful use of BIS requires additional training and at least some changes in attitude, supports the existing findings.

Another determinant proving to be significant in the use stage of the BIS adoption process is *organizational data environment*. As technology becomes ever more available, including for SMEs, data quality, availability, and ETL are not so much an issue anymore. If BIS becomes an integral part of an ERP, the organizational data environment becomes even less decisive since we can expect to have better input for BIS as opposed to when BIS is not sufficiently integrated with the transaction system (Puklavec et al., 2014). Consequently, both adopters and non-adopters feel confident in the field of ODE and thus ODE does not play a significant role in BIS evaluation and adoption. The relevance of ODE first appears in the use stage where it becomes clear that, without an adequate data environment, fast and reliable results are questionable and may likely impact the BIS use and further success (Popovi• et al., 2012).

In contrast to ODE, *organizational readiness* does not influence the use stage of BIS adoption but emerges as a significant determinant in the evaluation and adoption stages. These findings confirm some earlier studies (e.g. Hameed et al., 2012, Mehrtens et al., 2001, Tsai et al., 2010) and extend them with insights about behavior in the use stage. These findings, merged with firms' high average appraisal of their own organizational readiness, suggest that firms not using BIS find themselves ready to use it. However, there are other determinants (i.e. management support, project champion, BIS is part of ERP, and organizational data environment) that are reducing the impact of organizational readiness on BIS use.

Within the domain of *external support* for IT innovation adoption, previous studies presented mixed results (Quaddus and Hofmeyer, 2007). Our study results contradict certain earlier works (e.g. Hong and Zhu, 2006, Lee and Larsen, 2009) but provide reasonable support for Premkumar and Roberts (1999) postulations about two possible causes of the non-significance of external support for IT adoption. First, some variables could represent such a dominant influence on the adoption that they erode the impact of other variables. Similar findings can be found in Caldeira and Ward (2002) where management involvement and IS/IT knowledge availability are seen as dominating over external support. In our case, the prevailing determinant could be BIS being part of ERP. Since ERP support also covers support for BIS, and since an integrated BIS solution basically requires substantially less support, additional external support may not be necessary. Second, as both adopters and non-adopters can use the same resources, the extent of providers' external support is equal for both groups.

Consequently, external support is not a significant variable in any of the adoption process stages.

### 6.2 Practical implications, limitations, and future research

Our study also holds important insights for organizational decision-makers, IT solution providers, and IT specialists with an interest in BIS adoption and use.

To begin with, as perceived relative advantage does not significantly affect BIS adoption, communicating BIS advantages might not be a primary focus for BIS providers. They should, instead, concentrate on developing organizational capabilities to improve BIS adoption readiness or consider the possibility of offering a BIS solution bundled with ERP. In place of investing in BIS-related promotional activities, solution providers should seek close cooperation with key users (predominantly the BIS project champion) and emphasize the prominence of organizational readiness.

Next, BIS solution providers should steer away from emphasizing BIS cost-efficiency and should not further inflate cost-related expectations about BIS because cost-efficiency does not influence evaluation. Moreover, as expectations are already quite high, additional promotional activities in this regard could produce an opposite effect, i.e. disappointment and the abandoning of the adoption. On the other hand, adopting firms should do their best to keep the expectations of BIS cost-efficiency at moderate levels so their overambitious prospects do not negatively influence the adoption and use of BIS.

We further advise firms with the possibility to adopt BIS as part of their ERP solution to consider this option over adopting a third-party BIS solution. Moreover, it is sensible for firms that are considering adopting new ERP or replacing their present ERP to choose such an ERP solution that encompasses an integrated BIS. Accordingly, ERP providers as well as BIS providers should work together to integrate their solutions and develop package solutions. Consequently, implementations of these solutions would be more effective and users would be able to avoid the use of redundant resources as a consequence of separate adoption endeavors (i.e. one for BIS and one for the ERP solution).

BIS solution providers need to recognize that, without securing sufficient management support for the BIS adoption, success is likely at stake. As management support is one of the key determinants for evaluation, solution providers should focus their efforts on emphasizing the importance of BIS for decision-making and its role in the execution of core business processes. Firms that want to adopt BIS should also be aware of the significance of management support, particularly for the use phase, or it is likely a firm will not exploit the implemented BIS to its fullest potential. In this context, management accompanied by the BIS project champion must articulate the firm's vision and emphasize a sense of importance in adopting BIS to increase stakeholders' commitment (Bose and Luo, 2011). In this vein, it is vital that firms striving for successful BIS adoption ensure a qualified individual to take on the project champion role. BIS providers should help firms find, train, and empower such an individual and maintain close cooperation with the project champion for the duration of the project.

In addition, both adopting firms and BIS providers should pay proper attention to the organizational data environment, even though it is not significant for the early phases of the adoption process. If the data environment is not at the proper level, this issue should be addressed before adopting the BIS solution as the organizational data environment has been found to be significantly linked to use, which ultimately affects adoption success.

Firms intending to adopt BIS should also reassess their overall organizational readiness. BIS providers should assist their customers in this endeavor. As organizational readiness already influences BIS adoption in the evaluation stage, providers should help potential adopters understand the readiness factors linked to adoption, e.g. by including a clear description of requirements in their proposals and possibly also instructions on how to achieve them.

In addition, based on the identified low external support of providers, BIS solution providers could improve their service offerings in order to strengthen their competitive advantages. On the other hand, BIS adopting firms should not rely on external support too greatly; they should instead draft appropriate adoption strategies focused on other determinants, such as presence of the project champion, management support, organizational readiness and, last but not least, consider the possibility of adopting a BIS that forms part of their present or future ERP.

Despite its theoretical and practical contributions, our study entails some limitations and opens avenues for future research. First, our work was mainly focused on the adoption of BIS in SMEs and was also geographically limited. Future work could use the proposed research model to replicate BIS adoption within other environments (e.g. different firm-size segments, across other countries) to advance our understanding of BIS adoption. Second, because BIS as part of the ERP solution was recognized to play an important role in BIS adoption – with research in this area being still in its infancy – we urge academics to further explore its role in other related research areas. Future research could develop similar determinants also for other IS/IT innovations and test them in various environments. Third, we encourage scholars to extend the proposed research model by introducing BIS value constructs into the model in order to examine the impact of BIS adoption and use on firm performance.

## 7. Conclusions

BIS are valuable tools for SMEs in competitive and uncertain environments. This study explores how technological, organizational, and environmental factors affect individual BIS adoption stages. Drawing on the technology-organization-environment framework and IT adoption literature led to the development of research hypotheses and a conceptual framework that explicates these relationships in the BIS context. We conducted an empirical study among small and medium firms to test the research model and hypotheses.

Our study contributes to understanding of BIS adoption at the firm level as, to the best of our knowledge, no study has so far examined this phenomenon. Second, this research provides a reliable and valid instrument for predicting BIS adoption. In particular, we propose BIS is part of ERP as a novel determinant of BIS adoption. Further, most studies in the area of IT innovation adoption focus on the adoption stage of the adoption process, yet this is one of the few studies to conduct comprehensive research on all three adoption phases, i.e. evaluation, adoption, and use (for other works, see Bose and Luo, 2011, Chan and Chong, 2013, Thomas et al., 2015, Zhu et al., 2006b, Martins et al., 2016). Lastly, by examining both the direct and total effect of the independent variables we provide a broader understanding of the BIS adoption phenomenon given that evaluation, adoption, and use are not individual processes but are related and co-dependent stages of the adoption process.

This study represents important progress in our theoretical understanding of the role of technological, organizational, and environmental factors across the different BIS adoption stages. The results also provide instrumental insights for managers and solution providers to understand the influence of various determinants to more effectively conclude the adoption process. We hope this work inspires future attempts to elaborate on our findings.

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## **Appendix:** Measurement items

| Constructs | Items | References |
|---|---|---|
| Relative advantage/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>RA1 - BIS allow companies to make right decisions and to take right actions.<br>RA2 - BIS improve the quality of decisions and actions.<br>RA3 - BIS enhance the effectiveness of decisions and actions in companies.<br>RA4 - BIS enable to perform decisions and actions more quickly.<br>RA5 - BIS give a greater control over a business. | our own because of specifics of BIS;<br>basis was:<br>(Ifinedo, 2011; Moore & Benbasat, 1991; Oliveira et al., 2014) |
| Cost/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>C1 - BIS are more cost effective than other types of information systems.<br>C2 - Organization can avoid unnecessary cost and time by using BIS.<br>C3 - BIS save costs related to time and effort. | (Chong and Chan, 2012) |
| BIS is part of ERP/R | We consider Enterprise resource planning (ERP) as a business management software that a company can use to collect, store, manage and interpret data from many business activities.<br><br>Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>BPE1 - BIS is built-in in our ERP.<br>BPE2 - Our ERP incorporates BIS.<br>BPE3 - BIS was provided as an integrated part of our ERP. | our own<br>(Puklavec et al., 2014) |
| Management support/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>MS1 - Our management actively participates in establishing a vision and formulating strategies for utilizing BIS.<br>MS2 - Our management communicates its support for the use of BIS.<br>MS3 - Our management is likely to take risk involves in implementing BIS. | (Chong and Chan, 2012) |
| Rational decision-making culture/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>RDMC1 - Our company encourages to make informed decisions.<br>RDMC2 - Our company encourages to look for data/information to inform decision-making.<br>RDMC3 - Our company shows organization-wide respect for measuring and evaluating evidence when making decisions.<br>RDMC4 - Our company encourages decision-making processes that include quantitative/numeric analysis. | (Kulkarni et al., 2017) |
| Project champion/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>PC1 - BIS have strong advocates in our company.<br>PC2 - There are one or more people in our company who are enthusiastically pushing for BIS.<br>PC3 - There are one or more people in our company who are constantly praising BIS benefits. | (Gu et al., 2012)<br><br>+ added PC3 |
| Organizational data environment/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>ODE1 - The data currently available in our company is of high quality.<br>ODE2 - The data that we currently use in our company is reliable.<br>ODE3* - We have clear agreement on a common set of data definitions | (Ramamurthy et al., 2008) |

| Constructs | Items | References |
|---|---|---|
| | and business rules in our company at this time.<br>ODE4 - Overall, information is shared openly throughout our organization.<br><br>* - inversed (original: We do not have…) | |
| Organizational readiness/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>OR1 - Our company knows how information technology (IT) can be used to support our operations.<br>OR2 - Our company has a good understanding of how BIS can be used in our business.<br>OR3 - We have the necessary technical, managerial and other skills to implement BIS.<br>OR4 - Our business values and norms would not prevent us from adopting BIS in our operations.<br>OR5 - Our company possesses sufficient resources (financial, technological…) to adopt BIS. | (Ifinedo, 2011)<br><br>+<br>resources (OR5) |
| External support/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>ES1 - There are businesses in the community, which provide technical support for effective use of BIS.<br>ES2 - Technology vendors actively market BIS by providing incentives for adoption.<br>ES3 - Technology vendors promote BIS by offering free training sessions. | (Premkumar and Roberts, 1999)<br>- adopted to BIS |
| Evaluation/R | Please rate the degree to which you agree with the following statements (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br><br>E1 - Our company collects information about BIS with the possible intention of using it.<br>E2 - Our company has conducted a pilot test to evaluate BIS.<br>E3 - Our company intends to use BIS if possible. | (Chan and Chong, 2013) |
| Adoption/R | A1 - At what stage of BIS adoption is your organization currently engaged?<br>- Not considering.<br>- Currently evaluating (e.g. in a pilot study).<br>- Have evaluated, but do not plan to adopt this technology.<br>- Have evaluated and plan to adopt this technology.<br>- Have already adopted BIS.<br>A2 - If you're anticipating that your company will adopt BIS in the future. How soon do you think it will happen?<br>- Not considering.<br>- In more than 5 years.<br>- Between 2 and 5 years.<br>- Between 1 and 2 years.<br>- In less than 1 year.<br>- Have already adopted BIS. | (Thiesse et al. 2011) |
| Use/F | U – Our company uses BIS technology/solution of (1- Strongly disagree; 2; 3; 4; 5; 6; 7- Strongly agree; X - Not applicable):<br>Analyses<br>Reporting<br>Planning<br>Dashboard<br>Data mining | our own, based in<br>(Zhu et al., 2006) |

| Constructs | Items | References |
| --- | --- | --- |
| | Forecasting<br>Alerting<br>Benchmarking<br>Other, please specify | |

*Note:* R – reflective; F – formative;