Which Factors of Business Intelligence Affect Individual Impact in Public Healthcare?

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Abstract

In this paper, we examine the relationship between business intelligence (BI) quality, task characteristics and individual impact of the system from an end-user perspective at 12 public hospitals. 1,352 BI end-users answered the questionnaire. Linear regression was used to test the research model empirically. If organisations in the public health sector want high individual impact, the following factors are essential. Firstly, system quality must be high. Secondly, the system must support the tasks that the BI user solves with the system. Thirdly, task difficulty is positively and significantly related to impact. In conclusion, it is essential that the user perceives the task as being important. The user's perception of task interdependency and task specificity does not influence individual impact. Future research should focus on different healthcare settings with different types of BI system.

Keywords:

Business intelligence, Public healthcare, End-user success.

Introduction

Public healthcare sectors generate large amounts of data relating to patient records, compliance, and patient care [1]. Therefore, there is an increasing interest in using business intelligence (BI) within both the private and public health sectors. 'BI' is "…commonly used to describe the technologies, applications, and processes for gathering, storing, accessing, and analysing data to help users make better decisions" [2]. This definition implies that if BI is utilised to enhance decision-making, it can affect an organisation's performance. According to Mettler and Virmarlund, the value of BI in a healthcare setting is not only in providing information but also that "…its contribution is in enabling new ways of working, allowing the integration of information and organisations and the measurement of outputs in real time" [3].

One issue that has dominated research in information systems (IS) is how organisations can achieve success. In the literature, there are countless definitions and goals for success [4]. In this article, success will be measured as the dependent variable "individual impact", because there is a relationship between the individual impact and the organisational impact of IS [5]. In this study, success is based on an end-user perspective. Success in public healthcare is interesting because there is a significant amount of data and a complex system landscape [6]. There is a difference between evaluating IS in the public and private sectors [7], and most studies have been conducted in private organisations [4, 8] while public sector studies are lacking. In this regard, our goal is to assess the individual impact of business intelligence in public hospitals and associated administrative areas in Denmark. Unlike many other organisations, there is a high degree of diversity in BI users in healthcare, since BI is used to support both administrative and clinical decisions. Therefore, user types range from administrative employees to clinical staff and they solve many different types of task with BI [9]. Hence, it is interesting to look at the relationship between task characteristics, BI quality, and individual impact in particular in a healthcare setting[10].

In this paper, we test the relationship between five task characteristics, information quality, system quality and individual impact in 12 public hospitals and their administration. The article contributes to the subfield of the relationship between task and technology in public healthcare. The article is organised as follows: in the next, second section, we present related literature and the research model, and discuss our methods in the third part In the fourth section, we analyse the findings, which are then discussed. The final section covers our conclusions.

Research model

In recent years, there has been an increasing amount of literature on the factors for BI success [11]. Traditionally, these studies have been based on one or several of the success measures from DeLone and McLean's IS success model [5, 12]. One measure of BI success is individual impact [4], and DeLone and McLean defined this as "an indication that an information system has given the user a better understanding of the decision context, has improved his or her decision-making productivity, has produced a change in user activity, or has changed the decision maker's perception of the importance or usefulness of the information system" [5].

Numerous independent variables have been investigated for their effect on individual impact. However, few studies have examined the relationship between task characteristics and individual impact from an end-user perspective [11, 13]. Tasks are activities that support an organisation, and the role of IT systems is to support the completion of these [14]. The purpose of using IS systems is to inform or to automate tasks [15]. Petter et al. [13] have categorised task characteristics in relation to information systems to include task compatibility, task significance, task difficulty, task interdependence and, moreover, task specificity. The fit between the user's task and BI is referred to as 'task compatibility' [13]. 'Task interdependence' reflects whether the completion of a BI-related task depends on others, while the importance of the task is characterised as 'task significance' [13]. 'Task difficulty' is the extent to which a user believes that BI makes it possible to complete complicated tasks [13]. Finally, 'task specificity' is the level of clarity of the task supported by BI [13].

BI quality can be assessed using system quality and information quality [16]. Ease of use, data quality, and maintenance of the BI system are referred to as 'system quality' [17], while the quality of the output from BI is known as 'information quality' [17]. As use is related to the system's yield, it is measured regarding the time needed for use [17]. The use of information systems for specific tasks is often mandated, therefore user satisfaction is measured in relation to the particular system [18]. In this study, the user's overall satisfaction with BI is measured.

The central question in this article is how task characteristics and BI quality are related to individual impact. In previous research, single tasks have been tested against individual impact, but no studies have tested all of the above task characteristics with individual impact [13] The research model is presented end in the figure below.
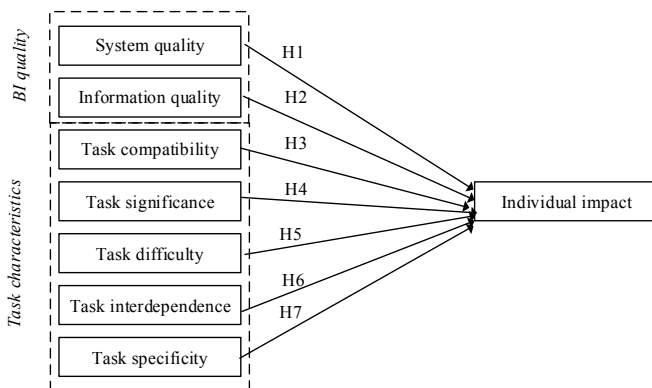

Figure 1- The research model

Based on the above, the following hypotheses can be proposed:

H1: There is a positive relationship between system quality and individual impact

H2: There is a positive relationship between information quality and individual impact

H3: There is a positive relationship between task compatibility and individual impact

H4: There is a positive relationship between task significance and individual impact

H5: There is a positive relationship between task difficulty and individual impact

H6: There is a positive relationship between task interdependence and individual impact

H7: There is a positive relationship between task specificity and individual impact

Methods

Data collection process

To test the hypotheses, 12 public hospitals in the same region in Denmark were selected as research sites. All employees who had access rights to BI were chosen as the sample, including members of management, nurses, doctors, and administrative staff, etc. First, an email was sent out explaining the project and encouraging employees to participate. Afterwards, each respondent received an email with a link to the questionnaire, which was prepared using an online survey program. The first question focused on whether the respondent had used the BI system. If the respondent answered "No", no further questions were asked. Later, a reminder was sent two weeks after the initial distribution of the survey to encourage respondents to complete the questionnaire. Before the questionnaire was sent out, questions were selected by a comprehensive literature review [19] and a test among senior researchers in the relevant field of research. Of the 4,232 employees invited to participate, 1,351 responded, giving a response rate of 32%. Of these, 605 indicated that they did not use the BI system. This left 746 responses to be used for the data analysis.

Questions used in the survey

Our questions, shown in Table 1, have all been used in previous information systems studies [5, 12, 20–22]. However, we translated the questions into Danish and ensured that they fitted the specific context of our sample. The survey was part of a larger research project and so, in addition to the questions listed in Table 1, the questionnaire contained questions requesting data not used in this particular paper [6, 10]. In the questionnaire [BI] was replaced with each organisation's term for BI, for instance 'Tableau'.

Table 1- Constructs, questions and Cronbach's alpha

Construct	Question	Cronbach Alpha
Individual Impact	I can efficiently make my reports using BI. [20]	0.844
	I can complete my reports quickly using BI. [20]	

Construct	Question	Cronbach Alpha
	I can complete my reports using BI. [20]	
System Quality	BI is easy to learn.[20]	0.826
	BI is easy to use. [21]	
	The information in BI is easy to understand.[22]	
Information Quality	Data are displayed in a consistent format in BI. [22]	0.744
	The data in BI have high validity. [22]	
	Other employees in the region also think the data in BI have high validity. [22]	
Task compatibility	This information is useful for my tasks.[22]	0.817
	This information is complete for my needs. [22]	
	This information is relevant to my tasks. [22]	
	This information is relevant to my tasks. [22]	
Task significance	The tasks I complete in BI are an important part of my tasks. [23]	0.776
	I make decisions based on the tasks I complete in BI. [23]	
	My tasks completed in BI are important to other employees in the organisation. [23]	
	Other people make decisions based on the tasks I completed in BI. [23]	
	My tasks in BI are important for collaborators outside the organisation. [23]	
Task difficulty	BI makes it possible to complete complicated tasks. [23]	-
Task Interdependence	If I do not complete my tasks in BI, one or more employees in the organisation cannot complete their tasks. [23]	-
Task Specificity	The tasks I complete in BI can be done in more than one way.[24]	-

Cronbach's alpha is calculated in the third column of Table 1 for the following constructs: individual impact, system quality, information quality, task compatibility and task significance. All values are above the threshold value of 0.7 [25], which indicates good reliability. Task difficulty, task interdependence, and task specificity represent single items and Cronbach's alpha is not therefore calculated.

Findings

The hypotheses are tested using multiple linear regression. Zviran et al. [26] have put forward a hypothesis regarding gender and age being antecedents of individual impact. Therefore, we have chosen to include these as control variables. Consequently, the following regression was used:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + e$$

where Y is individual impact, X_1 is system quality, X_2 is information quality, X_3 is task compatibility, X_4 is task significance, X_5 is task difficulty, X_6 is task interdependence, X_7 is task specificity, X_8 is gender, X_9 is age, and finally, e is the error term.

Table 2- Regression results

Y=individual impact	B	Std. Error	Beta	t	Sig.
(Constant)	-,207	,180		-1,153	,250
System quality	,505	,044	,440	11,567	,000
Information quality	,089	,054	,069	1,646	,100
Task compatibility	,229	,051	,187	4,466	,000
Task significance	,145	,040	,129	3,586	,000
Task difficulty	,098	,037	,098	2,664	,008
Task interdependence	-,021	,026	-,028	-,813	,417
Task specificity	-,030	,035	-,028	-,864	,388
Gender	,002	,004	,015	,495	,621
Age	-,010	,007	-,044	-1,434	,152
Notes: $R^2=0,463$ Adj. $R^2=0,455$					

The results of the regression are shown in Table 2. When inspecting the main effects, it can be seen that system quality and task compatibility are positively related to individual impact ($p<0.001$). Task difficulty is also positively and significantly associated with individual impact ($p<0.01$). It can also be seen that information quality, task interdependence and task specificity are insignificant. The two control variables (gender and age) are also insignificant. In sum, system quality, task compatibility, task significance and task diffi-

culty have an impact on whether the user experiences individual impact through using BI.

Discussion

Based on the regression analysis, the findings of this study regarding the seven hypotheses are shown in Table 2.

Higher system quality leads to higher individual impact from employees in the public health sector using BI (H1). If consideration is given to the context in which BI is evaluated, it can be concluded that employees in the public health sector will experience higher individual impact if the system is easy to understand, learn and use.

Surprisingly, there is an insignificant relationship between information quality and individual impact (H2). Therefore, higher information quality does not necessarily lead to higher individual impact of BI. The finding is surprising because other studies, for instance, D'Ambra and Rice [27] and Shih [28] find a relationship between information quality and both the quality of work and time savings. One reason why the relationship between information quality and individual impact (H2) is insignificant may be that users will not experience task compatibility if there is inadequate quality of information. Therefore, information quality can be perceived as a hygiene factor that is assumed to be present.

Access is the relationship between task compatibility and individual impact, which was found to be positive and significant (H3). That is, if an employee's tasks and the system have a positive fit, they will find that the tasks can be completed quickly and efficiently. Several studies have confirmed this positive and significant relationship [29, 30].

Two other task characteristics that are positive and significantly related to individual impact are task significance and task difficulty (H4 and H5). The more critical the user considers the tasks that are solved with BI, the higher the individual impact (H4). Few other studies have confirmed the relationship, even though the finding was expected [13]. One explanation may be that by completing complicated tasks quickly and efficiently, the user perceives the individual impact of BI to be higher. The same relationship applies to task difficulty; the more difficult a task is for the BI user to solve, the higher they consider the individual impact of using BI (H5). A reason for this may be that they perceive BI as a means of solving their tasks.

The relationship between task interdependence and individual impact (H6) as well as the relationship between task specificity and individual impact (H7) were insignificant. In the literature, there is mixed support for this particular relationship; a study by Kim et al. [31] discovers support for it, while Marchal et al. [32] does not.

In summary, there is a relationship between system quality, task compatibility, task significance, task difficulty and the users' individual impact of BI in the public sector. The remainder of the relationships tested are insignificant. These findings are supported in the literature, but no studies have previously been performed with so many task characteristics in a BI and public sector setting to identify which factors contribute to individual impact.

Conclusion

The primary goal of the current study was to determine which BI quality and task characteristics lead to individual impact in a public healthcare setting. This is a contribution, as this has not been widely researched before in a healthcare setting. If organisations in the public health sector want high individual impact for BI users, the following things are essential. Firstly, system quality must be high. Secondly, the system must support the tasks that the BI user solves with it. In addition, task difficulty is also positively related to impact. In conclusion, it is essential that the user perceives the task as being important.

The findings in this article are subject to more limitations. First, the study is conducted in one specific country and only in the public sector. Moreover, only one specific type of BI system has been investigated. Therefore, future research should focus on different healthcare settings with different types of BI systems and take national differences into account. Also, the operationalisation of individual impact could be further developed. We use the construct by Wang & Liao[21] who focus on the effect the BI system has on the ability to make reports but other ways of measuring impact could also be tested. Likewise, some of the measures focus on the perception of the user. Further research should consider if some of these measures could be measured more directly.

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