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The Impact of Mobile Business Intelligence Applications In Organizational Performance

Diogo Alexandre Mendes Marques

Master in Decision Integrated Support Systems

Advisor:
PhD, João Carlos Amaro Ferreira, Assistant Professor, ISCTE-IUL

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October, 2022

TECNOLOGIAS
E ARQUITETURA

School of Technology and Architecture (ISTA)

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Acknowledgments

I thank everyone who assisted me with the work that follows and to recognize their contributions. I want to start by expressing my gratitude to Professors Carlos Tam and Jose C. Ferreira, who served as my project's advisers, for their help, participation, and support.

I also want to express my gratitude to all the lecturers I had the opportunity to study with during this master's program. They taught us in a way that allowed us to advance academically and professionally and provided us with knowledge and insights into the world of integrated support systems.

I am also thankful to my friends and colleagues for their support during this program and all my studies at ISCTE by working alongside me on various projects that made it possible for me to reach this goal in my academic journey.

Finally, I could not have undertaken this journey without my girlfriend Sara Calado, who encouraged and motivated me, and never stopped supporting me, my sister Catarina Marques, my mother Vanda Mendes and father José Marques, who made this possible for me and showed great support as they never stopped encouraging me.

Resumo

A maioria das organizações hoje depende da tecnologia para processar e analisar grandes volumes de dados, exigindo o uso de ferramentas analíticas e estatísticas para agilizar a tomada de decisão, levando a decisões mais rápidas e melhores. Mobile Business Intelligence (MBI) quebra a barreira entre a informação crucial e sua acessibilidade. Pouco se sabe sobre a influência das aplicações MBI no desempenho organizacional. Este estudo propõe um modelo de investigação baseado no modelo de sucesso de DeLone e McLean e investiga como as aplicações MBI podem impactar o desempenho organizacional analisando os fatores que contribuem para tal. Para isso, recolhemos dados através de um inquérito online partilhado com utilizadores de aplicações MBI. Utilizando estes dados, um conjunto de 12 hipóteses foram testadas utilizando a modelação parcial de equação estrutural (PLS-SEM). Após análise, descobrimos que a qualidade do sistema e o valor percebido aumentam significativamente o uso de aplicações MBI, no entanto, a qualidade da informação não. A qualidade do sistema, a qualidade da informação, o valor percebido e o uso têm uma influência benéfica na satisfação do usuário, e a satisfação do usuário tem um impacto positivo no desempenho individual, bem como na vantagem relativa. Finalmente, descobrimos que o desempenho individual e a vantagem relativa têm um impacto positivo no desempenho organizacional. As conclusões deste estudo ajudam a entender os fatores por detrás da influência do MBI no desempenho organizacional, oferecendo uma melhor visão sobre o que procurar numa aplicação de MBI ao decidir adotar ou desenvolver um.

Palavras-Chave: Inteligência de Negócio; Aplicações Mobile; Performance Organizacional

Abstract

Most organizations today rely on technology to handle and analyse vast volumes of data, calling for the use of analytic and statistical tools to speed up decision-making, thereby obtaining faster and better conclusions. Mobile business intelligence (MBI) bridges the gap between critical information and its accessibility. Little is known regarding the influence of MBI applications on organizational performance. This study provides a research approach based on the DeLone and McLean information systems success model and explores how MBI applications can affect organizational performance by analysing the components that contribute to it. For that, we gather data from an online survey amongst MBI users – students and workers. We used partial least squares structural equation modelling (PLS-SEM) to assess the data against 12 hypotheses. We discovered that system quality and perceived value significantly increase the adoption of MBI applications, although information quality does not. System quality, information quality, perceived value, and use all have a beneficial influence on user satisfaction, and user satisfaction has a favourable impact on individual performance as well as relative advantage. Finally, we discovered that individual performance and relative advantage have a favourable influence on organizational performance. The findings of this study help identify the drivers of MBI influence on organizational performance, which is useful in providing insight into what to look for in an MBI application when deciding whether to adopt or develop one.

Keywords: Business intelligence; mobile apps; organizational performance

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List of Abbreviations

AVE - Average Variance Extracted

BI – Business Intelligence

CA - Cronbach's Alpha

CR - Composite Reliability

DSS – Decision Support System

HTMT - Heterotrait-Monotrait Ratio

IP - Individual Performance

IQ - Information Quality

IS – Information System

KPI - Key Performance Indicators

MBI - Mobile Business Intelligence

OP - Organizational Performance

PLS – Partial Least Squares

PV - Perceived Value

SEM - Structural Equation Modelling

SEM-PLS - Structural Equation Modelling and Partial Least Squares

SMEs – Small and Medium Enterprises

SYSQ - System Quality

TAM - Technology Acceptance Model

TAMMS - Technology Acceptance Model for Mobile Services

TTF - Task Technology Fit

US - User Satisfaction

USE - Use

VIF - Variance Inflation Factor

1. Introduction

1.1 Context

With the rise of technology in the last decade, businesses have incorporated many new technologies into their classic model through business management and analysis tools. Business today is dependent to a great extent on these novel tools due to the large amount of data that needs to be managed and supervised. Mobile business intelligence (MBI) is a convergence between business intelligence (BI) and the need for information mobility and accessibility, in which the goal is to make business intelligence and data analytics accessible anywhere and anytime. By the end of 2021 there were 7.1 billion registered mobile users and 6.378 billion smartphone users worldwide, meaning that there are almost as many mobile users as there are people in the world, and around 89% of those are smartphone users [1]. By the beginning of 2022 there were 13.4 million phones in Portugal, more than its current population [1]. The same is true in nations such as China, which has the most mobile users in the world. Mobile phones outnumber people because many users use separate devices for personal and professional purposes.

1.2 Topic Background

With all of this in mind, several studies have been conducted on MBI and its various elements, problems, applications, research methods, and so on. Tutunea [2] investigated MBI solutions, while Adeyelure [3] proposed a framework for the deployment of MBI within developing countries' small and medium enterprises (SMEs) to assist them in overcoming barriers and challenges that make it difficult or impossible for them to access this type of technology and information. Fang proposes an MBI acceptance model for organizational decision-making focusing on a global scale and not limited to smaller or bigger businesses, and reviews two existing MBI users' acceptance models for strategic organizational decision making: Technology acceptance model for mobile services (TAMMS) and technology acceptance model (TAM) [4]. To the best of our knowledge, little to nothing has been studied about MBI's impact on organizational performance. To address this gap, this study examines the influence of MBI apps on organizational performance, posing the question: what are the drivers of MBI in organizational performance?

1.3 Motivation

The motivation behind this study is to answer our question and better understand the drivers of MBI in organizational performance. While most of the published investigations regarding MBI performance focus on user experience and individual performance, this study looks at the global picture, with organizational performance as its main goal. In today's moving market and evolving business models, MBI gives companies the ability to quickly react to last-minute changes and to make last-minute or on-the-go decisions, bringing some competitive advantage to their business. Therefore, determining the drivers of MBI organizational performance will help to understand the degree to which MBI's apps impact organizations' performance.

To evaluate the success of MBI and its performance impact, the DeLone and McLean research model defines information systems (IS) success, which takes into consideration existing IS success evaluation measures and creates six categories that classify these measures, thereby covering different perspectives of evaluating IS success [5]. With this study, we will provide a more solid base for future investigation regarding MBI apps, and a base for organizations to know what the main and most important drivers are for MBI apps to positively contribute to the organizational performance.

1.4 Contributions

This study brings the scientific community and managers insights on the relationship between MBI and organizational performance and contributes to two main areas in the literature. Firstly, it explores MBI, which is an ongoing emerging technology that can be a very useful and advantageous technology for businesses and managers, and, to the best of our knowledge, filling an existing gap in the literature (the MBI relationship with performance). Secondly, and to the best of our knowledge, this study explores for the first time the combination between the DeLone and McLean model, through our adaptation of it, with MBI apps focusing on organizational performance as its dependent variable, thus contributing to the IS discipline on MBI. We expect this study to provide business managers with knowledge they can use when adopting or creating an MBI app.

1.4 Thesis Goal and Structure

The research question for this study is: what are the determinants of MBI organizational performance? That is, the goal is to determine if MBI applications have a beneficial influence on organizational performance and what elements contribute to that positive impact. We can predict the success of an information system based on MBI if we understand the causes underlying its beneficial influence on organizational performance. To that end, this study proposes its own research model based on the well-known IS success model presented by Delone and McLean [4], as well as various adaptations from other authors seeking to investigate the success of various types of information systems. In this model a set of relevant constructs is considered, and their relationships are tested using the structural equation modeling and partial least squares (SEM-PLS). This study's results will show how our independent variables affect organizational performance.

The structure of the paper is as follows. Following the research objectives, this study investigates the MBI concept and the base research model in the following section, via a literature review of the theoretical concepts that will be used in the model's construction and hypothesis formulation. Following that, the method used to collect the data sample, construct the variables, and measure them is explained. Following the application and explanation of the methodology, the results are extracted using the SEM-PLS approach and presented in the following section. Finally, the respective analysis and discussion are presented, followed by conclusions that suggest possible future research topics.

2. Literature review

2.1 Mobile Business Intelligence (MBI)

MBI is the result of the convergence between BI and the need for information accessibility and mobility. To better understand and approach this topic, it is important to start with an understanding of BI. BI is the process of gathering, organizing, analysing, exchanging, and monitoring data to aid decision-making. BI provides a set of strategies and tools that aid in the translation of vast volumes of data into succinct and meaningful information for managers, mostly using BI software. However, there are many definitions fof BI. For example, Negash and Grey defined BI as a "system that combines data gathering, data storage, and knowledge management with analysis to evaluate complex corporate and competitive information for presentation to planners and decision-makers, to improve the timeliness and the quality of the input to the decision process" [6]. "Business Intelligence is an umbrella term consisting of technologies and processes for gathering, storing and analyzing data to improve decision making" [7].

Business managers need to be able to always access critical information for decision-making, and traditional BI systems running on local servers are incapable of delivering real-time, accurate, and complete information and knowledge. With the requirement for updated information from mobile devices, along with real-time data integration, the use of MBI is needed. MBI presents a new approach to delivering, via mobile devices, a solution for distant data retrieval. Because of the growing use of mobile devices for business, MBI brings business information and analytics closer to the user with its ubiquitous remote access, easing senior management staff's reliance on their workstations, and office-based PCs render the typical executive workplace obsolete [4]. Peters defines MBI as "a system comprising both technical and organizational elements that present historical and/or real-time information to its users for analysis on mobile devices such as smartphones and tablets (not laptops), to enable effective decision-making and management support, for the overall purpose of increasing firm performance." [8].

MBI applications allow managers to have access to this information in formats like dashboards that incorporate key performance indicators (KPI), and/or graphics. In general, MBI applications can be defined and divided into three groups: mobile browser app (data are viewed via mobile, as if it were viewed on the website, offering very few capacities for interacting with

the data due to browser capacity limitations); customized app (such apps provide us with a specific format for devices, optimizing data interactive features, and taking advantage of mobile features); and mobile client app (data are viewed via mobile, as if it were viewed on the website. These apps allow for a fully optimized experience due to full interactivity). Tutunea mentions Trif and Visoiu's definition of MBI applications as a BI functionalities extension for mobile devices serving the purpose of giving information accessibility for decision-makers [2], [9]. Airinei identifies three different MBI usage models: Exceptions & alerts ("Some proactive alerts about events that fall outside predefined norms are received by users.") push reporting ("Some role-specific predefined reports, such as KPI, are pushed to executives (regardless of their location or their device) on a regular schedule.") and pull reporting ("Workers specify the information they want, using what input method is appropriate for the available device. The user could access almost any type of information available from a centralized server-based system.") [10].

Tutunea studied MBI solutions, concluding that the large majority of MBI solutions are conceived for IOS and Android, and that most of those solutions are available for download in the respective operating systems applications store [2]. By the end of 2021, there were 6.378 billion smartphone users worldwide, 70.01% of those are Android users and 29.24% are IOS users, totaling 99.25% of smartphone users, which means and shows that MBI is very accessible, making it easier for companies to start implementing this technology. Nevertheless, Fang studied and reviewed MBI acceptance models for organizations' decision-making, exploring the relationship between user acceptance and decision-making, finding that "the main driver for mobile BI initiative in organizations is the need to make fast and efficient decisions." [4]. The models (TAM and TAMMS) show the drivers behind adopting and accepting a new technology (TAM), specifically a mobile service (TAMMS), but in MBI specifically, the MBI solution needs to be integrated with the company BI solution so that trust and acceptance may be built. These studies combined show that the MBI adoption, although accessible, has its challenges to fully integrate the business process, and take full advantage of what it has to offer, turning it into a competitive advantage.

Following this evaluation of the literature, we found that little to nothing has been investigated regarding MBI utilizing organizational performance, highlighting the need to address this gap in the scholarly community.

2.2 DeLone and McLean - Information Systems Success Measurement

Many studies have been conducted regarding information systems' (IS) success and measuring it. Each IS success researcher has a different notion on how IS should be measured and the drivers behind its success, performance, and/or impact. DeLone and McLean conducted a study (Information Systems Success: The Quest for the Dependent Variable) with the objective of organizing the different research models. They reviewed a set of conceptual and empirical studies and created a model with a "more integrated view of the concept of I/S success", in which a "comprehensive taxonomy is introduced", dividing IS success into six major categories: *System Quality; Information Quality; Use; User Satisfaction; Individual Impact;* and *Organizational Impact* [5].

According to DeLone and McLean, for research to be able to accurately measure IS success, the drivers behind the dependent variable must be measured with a "similar degree of accuracy". The authors reinforce the importance of "defining the I/S dependent variable" [5]. As a result of the numerous studies conducted regarding IS success, a large taxonomy of variables measurements is introduced resulting in a number of levels by which these variables can be measured: *Technical level; Semantic level;* and *Effectiveness level*. DeLone and McLean cite Shannon and Weaver, defining the technical level as information production accuracy of the IS, the semantic level as the capacity of the system information to transmit its meaning, and the effectiveness level as the effect of the information on the system user. Mason expanded Shannon and Weaver's view relabelling the "*effectiveness*" level as "*influence*" level, suggesting that there is a need for there "to be separate success measures for each of the levels of information" and divided this level into three sub-categories: *Receipt, Influence on Receipt, Influence on System* [11]. These three levels proposed by Shannon and Weaver and expanded by Mason yield the six categories proposed by DeLone and McLean as shown in Figure 2.1 [5], [12].

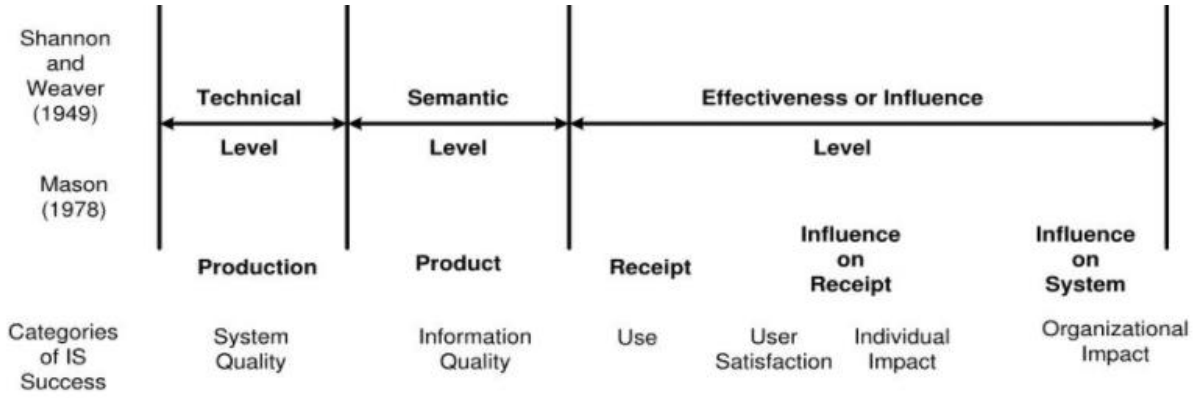


Figure 2.1 - Categories of IS success [4]

DeLone and McLean addressed and reviewed various researchers' approaches in the measurement of IS success, identifying the measures used by the authors in their studies, and their relation to the six proposed categories: system quality, information quality, use, user satisfaction, individual impact, and organization impact.

Reviewing this set of studies and approaches, a collection of observations emerged. "It is apparent that there is no consensus on the measure of information systems success" [5]. The various studies show that there are a variety of measures that can be used to assess IS success, and the selection of which measure to use depends on the goal of the study, stating that "some consolidation is needed". The existence of so many different variables makes it harder to compare study results and consequently "build a cumulative body of empirical knowledge". It is stated that "The six success categories and the many specific I/S measures within each of these categories clearly indicate that MIS success is a multidimensional construct and that it should be measured as such", and "Not enough MIS field study research attempts to measure the influence of the effort on organizational performance", and that only 28% of the reviewed studies attempted measuring the IS success through multiple categories [5].

All of this builds up to the creation of the DeLone and McLean IS success model (Figure 2.2), which incorporates a set of individual elements into an overall model. This model presents an interdependent approach to the various dimensions of IS success, making it a simpler, more organized, and more complete version of the existing models, and at the same time providing a more logical representation of how the six dimensions relate with one another, having some "predictive value" [5].

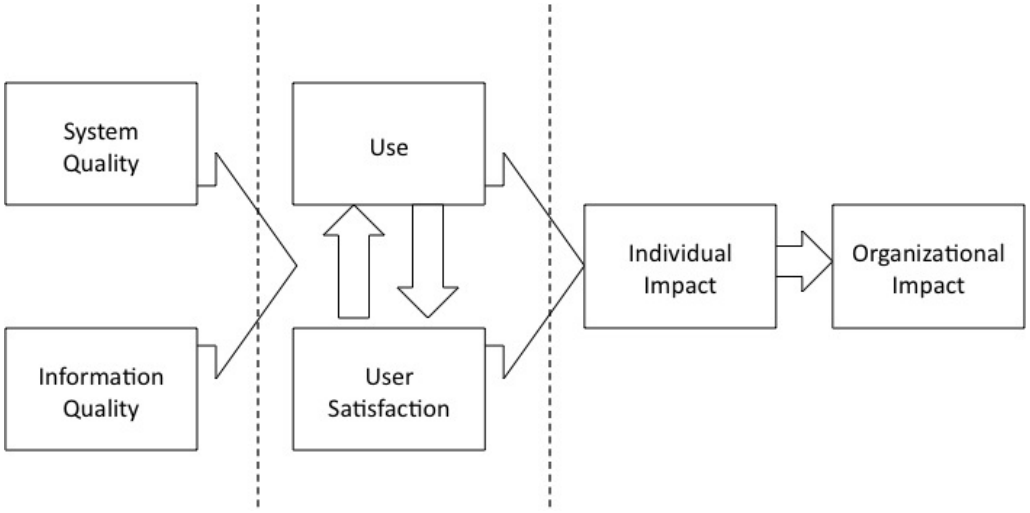


Figure 2.2 - IS success model [4]

Many authors have used this model as a tool to conduct studies regarding IS success, and various adaptations have been made and proposed to better fit specific scenarios, including the following. In 2017 Tam and Oliveira conducted a study "Understanding mobile banking individual performance" using the DeLone and McLean model and creating their own adaptation of it by incorporating two cultural dimensions, aiming to identify the drivers that affect the use and user satisfaction using the moderator effects of culture, leading to an understanding of its influence on individual performance [13]. In 2019 Tam and Oliveira then conducted a study regarding the influence that culture has on m-banking use and individual performance, using the DeLone and McLean research model alongside the Task Technology Fit (TTF) perspective, in which the original D&M IS Success model underwent an adaptation by incorporating some TTF dimensions, resulting in a more complete model in which technology and task characteristics are considered [5], [14].

In 2019 S.K. Sharma and M. Sharma conducted a study with the purpose of better understanding users' actual usage of m-banking using an extended model adapted from the DeLone and McLean IS success model in which the relationship between the constructs of service quality, information quality, system quality, trust, intention to use, satisfaction, and actual usage were tested, with the use of m-banking as dependent variable. The authors found that for m-banking, service quality and trust "are the key determinants" of users' satisfaction and intention to use, consequently influencing the actual usage of m-banking [15].

In 2017 Adebowale I. Ojo conducted a study using an adaptation of the DeLone and McLean information system success model with the objective of validating this model in the context of hospital information systems in developing countries. The author used SEM to validate a set of constructs: system quality, information quality, service quality, use, user satisfaction, and perceived net benefits. The author successfully measured the constructs using the DeLone and McLean model, finding that system quality and use are important measures of a hospital IS success, thereby validating the use of the DeLone and Mclean model in the context of hospitals' IS [16].

In 2010 Urbach conducted a study with the purpose of better understanding employee portal success, using the DeLone and McLean model and focusing on organizational performance as its dependent variable. The author presented an adaptation of the 1992 model, ending up with a model having nine constructs: system quality, information quality, process quality, collaboration quality, service quality, use, user satisfaction, individual impact, and organizational impact. Besides the model constructs, the author also used control variables that "might impact the models effectiveness level": knowledge-intensity of tasks, process standardization, and management support. These control variables are not part of the model, although they are part of the items used to collect the data needed to conduct the study and impact. The author successfully validated the model and found that collaborative features are an important success factor in employee portals and that this is the only variable that affects both use and user satisfaction, consequently impacting individual and organizational performance [17].

As our review of the literature revealed, there have been many different studies that adopted the DeLone and McLean model and created their own adaptations of it in the study of information system success. However, little to nothing has been studied about the impact that MBI has on organizational performance using this well-known model, revealing the need to fill this gap in the scholarly community. As a result, this study combines the necessity to investigate a gap in the scientific community regarding MBI with performance as its primary emphasis, as well as the assessment of MBI success in an organizational context utilizing the DeLone and McLean model.

3. Methodology

3.1 Research Model and Hypotheses

The research model for this study (Figure 3.1) uses organizational performance as its dependent variable describing the impact that MBI applications have on it. While various studies have been conducted regarding MBI individual performance among other individual-related topics, this study takes a broader approach, drawing the impact of usage, satisfaction, system and information quality, perceived value, relative advantage, and individual performance, on organizational performance. This model is an adaptation of the model proposed by DeLone and McLean, adding some important measurement topics that are considered relevant for this study [5].

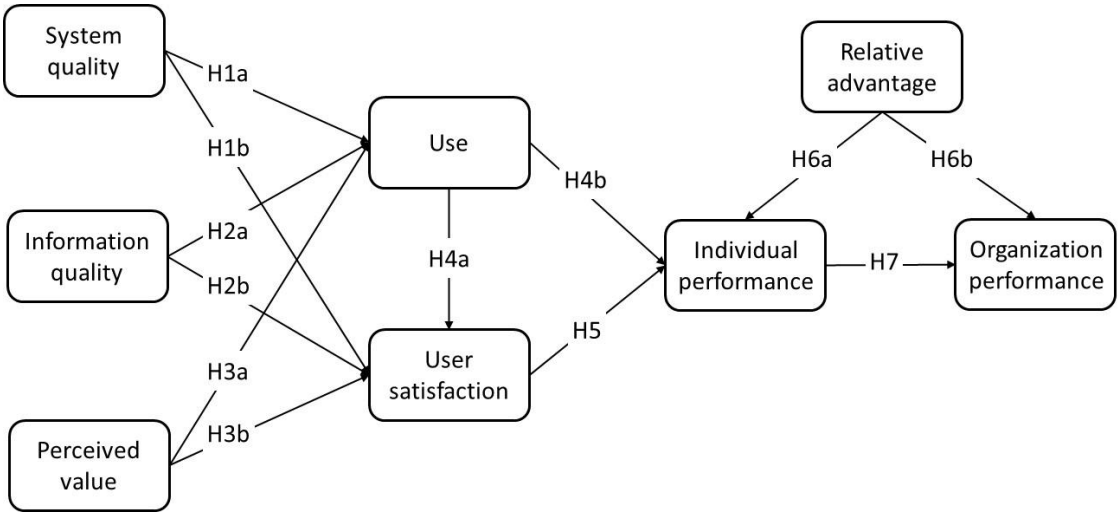


Figure 3.1 - Research model

System quality, as an evaluating construct of MBI impact on organizational performance, consists of the processing system itself. This dimension can be measured and evaluated by aspects such as response time, system accuracy, data accuracy, system flexibility, ease of use, reliability, online response time, and aggregation of details, among others [5], [18]. Airinei in 2010, studied MBI challenges and limitations and showed that the main problem with MBI is technical features such as poor resolution, tiny screens, low memory, and low processing power [10]. However, the evolution of technology overcame such challenges and limitations by increasing the quality of the systems. In MBI, system quality can be seen as the capacity of the system itself to help or allow the user to easily access information through MBI apps, and consequently to better perform the tasks. On the other hand, poor system quality can lead to a

frustrated user as it makes it harder to use these apps, leading to users not being satisfied with the system. Hence, two hypotheses are considered and tested in this study:

H1a. System quality has a positive influence on the use of MBI apps.

H1b. System quality has a positive influence on user satisfaction with MBI apps.

Information quality, as an evaluating construct of MBI impact on organizational performance, measures the quality of the information systems output, meaning the information that the system produces primarily in the form of dashboards, graphics, and reports, among others, rather than the quality of the system itself [5]. Urbach defines information quality as the quality of the output and its usefulness for the user, measuring it through usefulness, understandability, reliability, timeliness, completeness, and interestingness [17]. Most of these measures used by different authors for evaluating information quality rely on the user's perspective, making it subjective [5]. In MBI, information quality is the quality of the output of the system in the form of dashboards, graphics, tables, and KPI, among other forms of information, that can affect usage and user satisfaction depending on how relevant, accurate and up to date the information is, alongside its integrity, completeness, understandability, and timeliness, making it useful and reliable. Hence, two more hypotheses are considered and tested in this study:

H2a. Information quality has a positive influence on the use of MBI apps.

H2b. Information quality has a positive influence on user satisfaction with MBI apps.

The consumer perceived value measures the perception that the user has of the value of MBI apps. When a user has a positive perceived value of the technology service, he is more likely to try and use the service and adopt it. Perceived value also evaluates the user's perceived difference between its operational value and its cost. Yesim Can and Oya Erdil suggest that the "concept of perceived value is based on equity theory", meaning that individuals are concerned with the rewards they obtain from what they give, that is, the return of the value given [19]. Zeithaml defines perceived value as the "consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given" and suggests a direct impact of perceived value on the decision of purchase, hence resulting in a direct impact on use [20]. Kungumapriya and Malarmathi found that the relationship between perceived value and customer satisfaction has a mediator effect on quality, meaning that value has a positive impact

on customer satisfaction that leads to quality, and tested this effect on the mobile telephone sector [21]. Therefore, the following hypotheses are tested:

H3a. Perceived value has a positive impact on the use of MPI apps.

H3b. Perceived value has a positive impact on the user satisfaction of MBI apps users.

Use of the information created by the system, is also a subject of study amongst researchers who used different measures such as percentage of time decision support system (DSS) is used in a decision-making situation, acceptance of the report, frequency of use, frequency of voluntary use, the extent of use, use at anticipated level, and so on [5]. Use "measures the perceived actual use" of MBI apps [17]. The use of MBI apps allows users to have access to various forms of information regarding their business, anywhere at any time. With MBI apps users can easily, in less time and with less effort, access crucial information bringing the user satisfaction and impacting their performance when performing their tasks.

A satisfied user will continue to use MBI apps. User Satisfaction, as the user's response to the use of the information created by the system, is a subject that various researchers use as their main measure for measuring IS success, as these authors have found that user satisfaction is the most suitable measure when the objective is to measure the success of a specific system [5]. DeLone and McLean state that user satisfaction is most likely the most used measure for IS success, and that "it is hard to deny the success of a system which its users say that they like", and most of the measures are "conceptually weak or empirically difficult to obtain" [5]. "User satisfaction examines the successful interaction between the information system itself and its users" [22]. As shown, user satisfaction is one of the most important dimensions to be measured in the study of information systems success. Therefore, this model tests the relationship between the use and user satisfaction, and its effects on individual performance:

H4a. The use affects the user satisfaction of MBI apps.

H4b. The use of MBI apps impacts individual performance.

H5. The user satisfaction of MBI apps impacts individual performance.

The relative advantage that MBI apps can provide to users, such as information accessibility and reliability, can be a factor in the user's individual performance and organizational performance. Rogers defines relative advantage as "the degree to which an innovation is comprehended as being better than the idea it supersedes" [23]. In a study conducted by Sheikh,

Markerting, and Abdullah in 2017, the results show that relative advantage has a positive impact on organizational performance [24]. Therefore, the following hypotheses are tested:

H6a. Relative advantage has a positive impact on Individual Performance.

H6b. Relative advantage has a positive impact on Organizational Performance.

Individual impact is the effect of the information on the behaviour of the user, with impact measures being most likely the hardest ones to measure and classify [5]. DeLone and McLean state that because of its relationship to performance, a positive impact can be achieved by a department improving performance, but it can also mean that the IS has given the users a better understanding of the context, consequently improving their decision-making efficiency [5]. That is, the individual impact is the result of the individual benefits that come from the usage of MBI apps. It measures the "effect of the information system on the user's performance" [25].

These individual benefits can lead to a boost in organizational performance that affect the information system's overall performance. Organizational Impact, as the effect of information on organizational performance, is a subject studied by various authors using measures like cost reduction, profitability, inventory ordering costs, the overall cost-effectiveness of IS, IS contribution to meeting goals, return on investment, and so on, as measurement "tools" [5]. As organizational performance is the dependent variable of this study and considering the relationships between the dimensions mentioned, the following hypothesis is tested in this study:

H7. The effect of MBI apps on individual performance impacts organizational performance.

3.2 Measurement Method

This study was conducted in Portugal in the context of MBI users and BI analysts and developers. The target population was users of MBI apps. The constructs used in this model and connected to organizational performance, such as individual performance and relative advantage as well as use, user satisfaction, system quality, information quality, and perceived value are considered independent variables. Organizational impact is the dependent variable, which measures the impact that MBI apps have on the organizations' performance. These constructs were measured through an online survey, as explained below.

The items used in the survey to measure these constructs were modified and adapted from previously published sources from various authors such as Urbach, Tam & Oliveira, Yi-Shun Wang, Zhou, Mudzana & Maharaj, Almutairi & Subramanian, and Yoon [14], [17], [25]–[29] From Urbach came system quality (SYSQ), individual performance (IP), and organizational performance (OP), from Tam & Oliveira came information quality (IQ), from Yi-Shun Wang came perceived value (PV), from Zhou came use (USE), from Mudzana, T. & Maharaj and Almutairi & Subramanian came user satisfaction (US), and from Yoon came relative advantage (RA) [14], [17], [25]–[29].

The modified and adapted items that constitute the survey questions and that were used to measure the model are in Table 3.1.

Table 3.1 - Items

Constructs		Item	Adapted from
System quality	SysQ1	MBI apps are easy to navigate	Urbach et al. (2010)
	SysQ2	MBI apps allow me to easily find the information I'm looking for	
	SysQ3	MBI apps are well structured	
	SysQ4	MBI apps are easy to use	
	SysQ5	MBI apps offer appropriate functionality	
	SysQ6	MBI apps offer comfortable access to all the business information	
Information quality	InfQ1	The information provided by MBI apps is useful	Tam & Oliveira (2017)
	InfQ2	The information provided by MBI apps is understandable	
	InfQ3	The information provided by MBI apps is interesting	
	InfQ4	The information provided by MBI apps is reliable	
	InfQ5	The information provided by MBI apps is complete	
	InfQ6	The information provided by MBI apps is up-to-date	
Perceived value	PVal1	MBI apps are a good value for money	Yi-Shun Wang (2008)
	PVal2	The price of MBI apps is acceptable	
	PVal3	MBI apps are considered a good buy	
Use	Use1	I use MBI apps	(Zhou et al. 2010)
	Use2	I use MBI apps to retrieve information	
	Use3	I use MBI apps to manage information	
User satisfaction	Usat1	MBI apps meets information needs	Mudzana, T. & Maharaj, M., 2015; Almutairi & Subramanian (2005)
	Usat2	I think MBI apps are very helpful	
	Usat3	MBI apps are efficient	
	Usat4	MBI apps are effective	
Relative advantage	RAdv1	Using MBI apps will enhance efficiency in gathering information	Yoon et al (2014)
	RAdv2	Using MBI apps will make it easier to gather information	
	RAdv3	Using MBI apps will increase my effectiveness to gather information	
	RAdv4	Using MBI apps will increase the quality of the information that I gather	
Individual performance	IndP1	MBI apps save me time to access crucial information	(Urbach N. et al 2010)
	IndP2	MBI apps make it easier to access information.	
	IndP3	MBI apps are useful for the job.	
	IndP4	MBI apps increase daily productivity.	
Organizational performance	OrgP1	MBI apps improve management control	(Urbach N. et al 2010)
	OrgP2	MBI apps help the organization improve the efficiency of internal operations.	
	OrgP3	MBI apps help the organization improve the quality of working results.	

3.3 Data Collection

The data to support this study were retrieved via an online survey created on the widely held survey website "Qualtrics" between April 2022 and May 2022. The items in the survey were measured using a 1 (strongly disagree) to 7 (strongly agree) scale. As a test, a pilot study was conducted on a group of 30 college students and workers in Portugal, male and female, of widely ranging age. The promulgation of this survey followed a restricted policy, meaning that the survey was not published online. Instead, messages were sent directly to people in order to keep the final sample as real as possible and reach the intended targeted audience. Upon conclusion of the pilot study, during a two-month period starting at the beginning of April, a total of 500 messages were sent to workers and college students following the same demographic characteristics as in the pilot study, providing the link for respondents to participate in the survey. By the end of May 2022, a total of 199 responses were received, which corresponds to a 39.8 percent response rate. The survey was divided into two sections, the first presenting a set of items regarding the respondents' opinions on MBI based on their experience. The items that constitute this survey's first section are in Appendix A. The second section of this survey addressed the respondent's demographic characteristics. Table 3.2 shows the demographic details of the respondents. From a total of 199 respondents, 148 (74%) are men, showing that the gender distribution of the data is unequal, 107 respondents (54%) are 34 years old or younger, which shows that MBI apps are mostly used (in our sample) by younger people, most likely reflecting that this rising technology tends to be popular amongst the younger generations, 101 respondents (51%) have a master's degree or higher, while the bachelor's degree is held by 42% of the respondents, and 172 respondents (86%) are employees.

Table 3.2 - Demographic characteristics.

Distribution (n=199)					
Gender			Education		
Male	148	74%	High School or below	1	1%
Female	51	26%	Undergraduate degree	13	7%
			Bachelor	84	42%
Age			Master's degree or higher	101	51%
<25	37	19%			
25-34	70	35%	Occupation		
35-44	43	22%	Employee	172	86%
>44	49	25%	Self-employed	8	4%
			Student	14	7%
			Other	4	2%
			Unemployed	1	1%

4. Results

This study's results are derived through the structural equation model (SEM). SEM is a sophisticated multivariate approach that is being increasingly used in scientific research to investigate and assess multivariate causal links. SEM differs from other modelling tools in that it examines both direct and indirect impacts on previously hypothesized causal linkages. Following our proposed research model for this study, and its multivariate causal links, this is the most adequate model to correctly measure the relationships between the different dimensions present in the model, and their impact on organizational performance. There are several types of structural equation modelling. In this study, the model was estimated using partial least squares (PLS). The Partial Least Squares regression (PLS) approach lowers the predictor variables to a smaller number of predictors. These predictors are then utilized to carry out a regression analysis. SmartPLS was the software used to analyse the data retrieved through the survey, as this the most common software used in partial least squares structural equation modelling (PLS-SEM) [30].

4.1. Measurement model

The measurement model is presented in Tables 4.1, 4.2, and 4.3. In this model, internal consistency, convergent validity, and discriminant validity are tested. The results (Table 4.2) show that composite reliability (CR) and Cronbach's alpha (CA) are both greater than 0.7, indicating that the model has good internal consistency [31]. To test Convergent validity the average variance extracted (AVE) should be greater than 0.5, which means that the latent variables explain more than half of the variance of their indicators [32] As seen in Table 4.2 this model shows that the AVE for each variable is indeed greater than 0.5 (values in bold), indicating that the model is convergent, meaning that the constructs should correlate with related variables and not with dissimilar ones. To test discriminant validity Table 4.1 shows that for each variable the loadings are greater than the cross-loadings, as can be seen by comparing the values in bold to the others. As seen in Tables 4.2 and 4.3, to further test discriminant validity two more methods are considered: The square root of the AVE (values in bold) should be greater than the correlation of the constructs (Table 4.2) [32], and the Heterotrait-Monotrait (HTMT) ratio should be lower than 0.9 (Table 4.3) [31]. These results show that for each variable the square root of AVE is higher than the correlation between constructs, and the HTMT ratio is lower than 0.9, indicating that the model is discriminant. All in all, the measurement model results show that the model has good internal consistency,

convergent validity, and discriminant validity, and that therefore the constructs can be used to test the model.

Table 4.1 - PLS loadings and cross-loading

Constructs		SysQ	InfQ	PVal	Use	Usat	RAdv	IndP	OrgP
System quality	SysQ1	**.854**	.500	.505	.349	.567	.394	.374	.404
	SysQ2	**.800**	.593	.512	.333	.544	.435	.439	.430
	SysQ3	**.879**	.586	.511	.324	.538	.368	.393	.387
	SysQ4	**.863**	.557	.532	.310	.595	.388	.428	.384
	SysQ5	**.843**	.562	.489	.305	.572	.333	.360	.365
	SysQ6	**.807**	.552	.517	.349	.521	.428	.438	.406
Information quality	InfQ1	.464	**.809**	.483	.215	.553	.367	.514	.491
	InfQ2	.606	**.782**	.483	.179	.612	.464	.548	.521
	InfQ3	.503	**.808**	.501	.267	.574	.471	.556	.492
	InfQ4	.407	**.753**	.373	.125	.421	.268	.391	.339
	InfQ5	.623	**.715**	.496	.406	.529	.407	.509	.468
	InfQ6	.420	**.765**	.347	.257	.493	.301	.451	.346
Perceived value	PVal1	.546	.617	**.881**	.410	.712	.619	.723	.740
	PVal2	.460	.368	**.734**	.255	.433	.272	.386	.300
	PVal3	.546	.480	**.934**	.392	.618	.510	.588	.561
Use	Use1	.323	.310	.400	**.930**	.448	.289	.465	.313
	Use2	.345	.252	.386	**.894**	.426	.455	.421	.343
	Use3	.402	.322	.378	**.925**	.482	.334	.475	.385
User satisfaction	Usat1	.602	.521	.563	.569	**.829**	.448	.619	.510
	Usat2	.395	.605	.620	.363	**.827**	.534	.745	.686
	Usat3	.650	.646	.618	.407	**.916**	.521	.698	.600
	Usat4	.651	.638	.649	.387	**.898**	.479	.636	.537
Relative advantage	RAdv1	.459	.497	.526	.370	.565	**.939**	.587	.700
	RAdv2	.408	.469	.536	.319	.514	**.945**	.542	.610
	RAdv3	.435	.471	.600	.388	.553	**.956**	.583	.666
	RAdv4	.432	.432	.470	.378	.497	**.892**	.483	.557
Individual performance	IndP1	.409	.563	.536	.395	.649	.421	**.867**	.622
	IndP2	.420	.589	.629	.384	.718	.486	**.921**	.705
	IndP3	.466	.617	.657	.500	.745	.602	**.924**	.772
	IndP4	.424	.552	.624	.486	.667	.589	**.867**	.726
Organizational performance	OrgP1	.436	.552	.617	.378	.622	.600	.739	**.906**
	OrgP2	.398	.527	.553	.331	.585	.599	.736	**.927**
	OrgP3	.462	.527	.642	.336	.648	.679	.709	**.922**

Table 3.2 - Means, standard deviations, correlations, and reliability and validity measures (CR, CA, and AVE) of latent variables

Constructs	Mean	Stdev	CA	CR	SysQ	InfQ	PVal	Use	Usat	RAdv	IndP	OrgP
System quality	5.057	.912	.917	.936	**.842**							
Information quality	5.334	.825	.865	.899	.663	**.773**						
Perceived value	5.216	1.053	.815	.889	.607	.587	**.854**					
Use	4.335	1.773	.904	.940	.390	.323	.423	**.916**				
User satisfaction	5.295	1.061	.890	.924	.661	.695	.706	.494	**.868**			
Relative advantage	5.162	1.380	.951	.964	.465	.502	.573	.389	.572	**.933**		
Indiv. performance	5.568	1.111	.917	.942	.481	.649	.686	.496	.778	.591	**.895**	
Organ. performance	5.520	1.114	.907	.942	.471	.583	.658	.379	.674	.682	.793	**.918**

Table 4.3 - Heterotrait-Monotrait Ratio of correlations (HTMT)

Constructs	SysQ	InfQ	PVal	Use	Usat	RAdv	IndP	OrgP
System quality								
Information quality	.732							
Perceived value	.700	.672						
Use	.428	.352	.481					
User satisfaction	.732	.781	.807	.553				
Relative advantage	.498	.540	.619	.423	.619			
Individual performance	.524	.718	.763	.541	.858	.625		
Organizational performance	.516	.647	.726	.418	.748	.730	.865	

4.2. Structural model

The structural model was evaluated using bootstrapping based on 5,000 samples. However, before proceeding with the model evaluation, the collinearity of the model must be investigated. The variance inflation factor (VIF) displays values lower than 5, the threshold value for determining collinearity. The results of this model are in Figure 4 and can be summarized as follows.

The model explains 20.7% of the variation of the use of MBI. System quality ($\hat{\beta}$ =0.202; $p<0.05$), and perceived value ($\hat{\beta}$ =0.289; $p<0.01$) is statistically significant in explaining the use of MBI, thus confirming hypotheses H1a and H3a. Information quality is not statistically significant in explaining the use of MBI and consequently, the hypothesis H2a is not confirmed.

The model explains 66.6% of the variation in user satisfaction of MBI. System quality ($\hat{\beta}$ =0.171; $p<0.05$), information quality ($\hat{\beta}$ =0.328 and $p<0.001$), perceived value ($\hat{\beta}$ =0.333

and p<0.001), and use ($\hat{\beta}$ =0.181 and p<0.001) are all statistically significant in explaining user satisfaction, thus confirming the hypotheses H1b, H2b, H3b, and H4a.

The model explains 64.7% of the variation in individual performance of MBI. User satisfaction ($\hat{\beta}$ =0.606 and p<0.001), and relative advantage ($\hat{\beta}$ =0.198 and p<0.01) are statistically significant in explaining individual performance, thus confirming hypotheses H5 and H6a. Use is not statistically significant in explaining individual performance, and thus hypothesis H4b is not confirmed.

The model explains 69.8% of the variation of MBI impact on organizational performance. Relative Advantage ($\hat{\beta}$ =0.329 and p<0.001) and Individual Performance ($\hat{\beta}$ =0.598 and p<0.001) are statistically significant in explaining organizational performance, thus confirming hypotheses H6b and H7.

This study supports most of the hypotheses tested in this Delone & McLean derived model, with 10 hypotheses being confirmed in a total of 12 hypotheses.

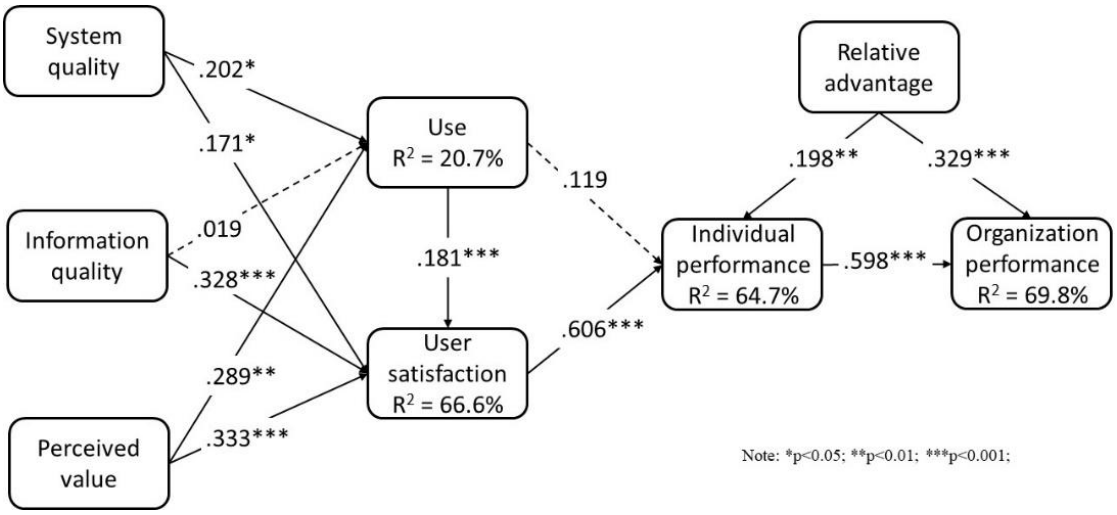


Figure 4.1 - Structural model results

5. Discussion

Little to nothing has been studied regarding MBI impact on organizational performance, and therefore the same applies to the use of this derived model and its application in this context. Our model tests the relationship between system and information quality and perceived value on the use of MBI and user satisfaction, leading to individual and organizational performance also impacted by relative advantage. This study's results show that 10 of the 12 hypotheses formulated and tested are supported.

The use of MBI is explained by system quality, information quality, and perceived value. The model explains 20.7% of the variation in MBI use. The hypotheses derived from system quality and perceived value (H1a, H3a) are supported, while the hypothesis derived from information quality (H2a) is not supported. These results are in part consistent to similar studies with information quality not having a positive impact on the use of information systems. However, this study shows that system quality has a positive impact on the use of MBI [17].

User satisfaction is explained by system quality, information quality, perceived value, and the use itself. The model explains 66.6% of the variation in MBI user satisfaction. All of the hypotheses derived from system quality, information quality, perceived value, and use (H1b, H2b, H3b, and H4a) are supported. These results are also consistent with similar studies [14], [17], [33].

The research model also explains 64.7% of the variation in individual performance. This variable is explained by use, user satisfaction, and relative advantage, with user satisfaction and relative advantage impacting individual performance while use does not, thus confirming H5 and H6a, but not confirming H4b.

Lastly, the research model explains 69.8% of the variation in organizational performance, our dependent variable, with individual performance and relative advantage explaining organizational performance, and its derived hypotheses being confirmed (H6b, H7). These results are consistent with a major study regarding IS and individual/organization performance, although our study explains the impact on organizational performance more accurately by obtaining higher R^2 values [17].

In the section below we discuss our results through a more theoretical and practical approach instead of looking at the results from a technical perspective. That is, we analyse the theoretical implications of the results.

5.1. Theoretical implications

The motivation behind this study was to better understand the factors behind the success of a mobile based information system that incorporates business intelligence in the context of an organization performance, and thus the factors behind "mobile business intelligence impact on organization performance". The degree of success of this information system is determined by measuring the relationships between these various factors, meaning that we analyse variables such as system quality, information quality, perceived value, use of MBI, user satisfaction, individual performance, relative advantage, and finally, the dependent variable organizational performance. For that, we collected data through an online survey, created using Qualtrics, and distributed the survey via social networks such as LinkedIn and WhatsApp. These data were then analysed using SmartPLS through a statistical method called SEM.

While most studies regarding information systems success focus on individual performance [13], [14], [34] this study takes a different and broader approach, focusing on organizational performance and covering a set of relevant dimensions.

Taking our results into account, this study shows how these different variables relate with each other, and consequently impact organizational performance. Regarding the effects of the variables on use, we can conclude that system quality influences the use of the MBI app. However, the study shows that information quality does not have a significant impact on the use of MBI apps, meaning that the users of MBI apps value the quality of the system itself and not so much the quality of the information when making the decision to use MBI apps or not, which may show that the consumer values an intuitive experience more than content. This may be indicative that a quality system results in such an intuitive experience, that the quality of the information turns out to be irrelevant to the decision of using or not using. In addition, the study shows that the perceived value of the consumers also has a significant impact on the decision to use MBI apps or not, meaning that if the consumer has a good perception of the value of the product, he will be more likely to use it.

Regarding the effect of the variables on user satisfaction, the study shows that system and information quality, perceived value, and the use of the apps, all have a significant influence in the satisfaction of the consumer, which shows that for information quality specifically, although not having a significant influence on the decision to use MBI apps or not, it impacts the user satisfaction of the consumer. This shows that the satisfaction of the user comes not only through the quality of the app but also through the quality of the information provided, a

factor that may not depend on the app, but on the organization itself. Regarding the effect of the variables on individual performance, this study shows that user satisfaction has a positive impact on the consumer's individual performance while the use itself does not, meaning that it is not the application itself that boosts individual performance but what comes from it. Relative advantage also is revealed to have a positive impact on individual performance, which once again shows that it is what comes from the app that boosts performance, and not the app itself. Finally, organization performance is directly and positively impacted by individual performance and relative advantage, which shows that the performance boost of the workers is reflected in a positive boost on organizational performance and that the adoption of these apps creates a competitive advantage that is also reflected in performance.

In summary, we found that MBI apps do have a positive impact on organizational performance, through a set of factors that are linked with each other and lead to these results. The overall quality, value, and use of MBI apps will affect user satisfaction, which will then result in an individual performance boost that together with the relative advantage that these apps create, will positively impact organizational performance.

This study also presents an interesting and different conclusion from what most studies regarding IS success show, i.e., that the use of the app is not directly impacting individual performance. This produces an interesting observation that when we are talking about information systems based on mobile technology and business intelligence, it is not the use of the app itself that creates a positive impact, but is instead the information and system quality, its value, and user satisfaction produced by the app that does.

5.2 Practical Implications

This study presents important information and implications for organizations and their decision-makers. The results show that from a managerial perspective an organization should consider adopting MBI as a tool. Focusing on the right aspects will create a competitive advantage and a performance boost of the workers, resulting in a performance boost of the organization.

This study suggests what the main factors to be focused on are when implementing new information systems. Our most important finding is regarding user satisfaction. It shows that user satisfaction is the bridge between the system and taking advantage of it by producing a boost in individual performance that will consequently impact the organization's performance.

It is important for the organization to note that the quality of the system, the quality of the information presented by the system, and the value perceived by the users, that is, their expectations, are the main factors that will impact the user's satisfaction, thereby making them the principal factors that the organization should focus on. Regarding the use of the app itself, the study suggests that information quality does not have a significant impact on it. However, the quality of the system does, which in practice suggests that an intuitive experience will make the difference between using the app or not, making the system quality also a very important factor for organizations to focus on. Information quality, although not having a significant impact on the use, has a significant impact on user satisfaction, and with information being a very important factor for fast and accurate decision-making, this is an issue that is under the control of the organization, making it also a very important factor to focus on.

To sum up, organizations should focus on creating user satisfaction by providing a quality system and creating quality information. Doing so, and working toward meeting the users' expectations, the adoption of MBI apps will result in a boost in individual performance and create a competitive advantage, leading to a positive impact on organizational performance.

6. Conclusions

With MBI as the primary focus of this research, a literature review was conducted to better comprehend this subject and what is already known in the community, identify gaps for this study to fill, and as a result, determine the most effective method to proceed. As concluded from this review, little to nothing has been studied about MBI apps, and most of the studies regarding IS success focus on individual performance. With that in mind, this study focuses instead on organizational performance, measuring the impact that MBI apps have on it and understanding what the drivers behind this impact are, by integrating the DeLone & McLean 1992 model with one of our own construction. The results show a significant effect of system quality and perceived value on use, and alongside information quality, on user Satisfaction. User satisfaction will then have a significant effect on individual performance leading to a significant effect, alongside relative advantage, on organizational performance, the main goal of this study and model. These results help business managers know the main aspects that should be focused when adopting or implementing an MBI solution.

However, like every study, this one also has its limitations. This study methodology is based on a cross-sectional sample, that is, it measures the perception of people in a very short and specific period. Also, this study does not consider the analysis of the moderator effect on the relationship between constructs. For future research a longitudinal study would allow for more accurate results, as it would measure the perception of people over a longer period of time, that is, instead of a sample being based on a two month period, expand it to a year or more, as it would allow for a comparative analysis. In addition, future research could also investigate the mediator effects of the relationship between constructs. With all of this in mind, we anticipate that future researchers investigating the influence of information systems on organizational performance will find this study beneficial and will gain insights into user behaviour.

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