The use of design science research in the development of a performance management system for hospitality

O uso de *design science research* no desenvolvimento de um sistema de gestão da performance para a hotelaria

Nuno António
Escola Superior de Gestão, Hotelaria e Turismo, Universidade do Algarve, Portugal
nmantonio@ualg.pt

Francisco Serra
Escola Superior de Gestão, Hotelaria e Turismo, Universidade do Algarve, Portugal
fserra@ualg.pt

Abstract

Since no Performance Management (PM) systems specific for the hospitality industry seem to exist in the market, it was decided to evaluate the commercial viability of such a system by developing one and making it available to hotels in the form of Software as a Service (SaaS). Software deployed in the cloud, delivered and licensed as a service is becoming increasingly common and accepted in a business context. Although PM and Decision Support Systems (DSS) are not usually distributed in the SaaS mode, there are some examples that this is changing. To evaluate the system in both the technical and business perspectives, a prototype was developed using the Design Science Research (DSR) methodology and made available to four hotels. The results revealed that hotels were very satisfied with the system and that building a prototype is a good method to develop and assess PM systems.

Keywords: software as a service; performance management; design science research; business intelligence; data analytics; hospitality.

Resumo

Uma vez que não foi encontrado nenhum sistema de Gestão da Performance (GP) específico para a indústria hoteleira, decidiu-se avaliar a viabilidade comercial de um sistema deste tipo, desenvolvendo e disponibilizando um sob a forma de Software as a *Service* (SaaS). Software implantado na *cloud*, disponibilizado e licenciado como um serviço, está a tornar-se cada vez mais comum e aceite em contexto empresarial. Embora os sistemas de GP e os Sistemas de Apoio à Decisão (SAD) não sejam normalmente distribuídos no modelo SaaS, há alguns exemplos que provam que tal está a mudar. Para avaliar o sistema tanto na perspetiva técnica como na de negócio, um protótipo foi desenvolvido utilizando a metodologia de Design Science Research (DSR) e disponibilizado a quatro hotéis. Os resultados mostraram que os hotéis ficaram muito satisfeitos com o sistema e que a construção de um protótipo é um bom método para desenvolver e avaliar os sistemas de GP.

Palavras-chave: *software as a service;* gestão da performance; *design science research*; inteligência empresarial; análise de dados; hotelaria.

1. Introduction

As an approach to evaluate the commercial viability of a *Performance Management* (PM) software system specific for the hospitality industry, since no such system seemed to exist during the research phase, a PM prototype was built.

This system was conceived to be distributed in the form of Software as a Service (SaaS) and to use dashboards and a broad set of metrics and *Key Performance Indicators* (KPIs) about hotel performance, which was thought to be of interest to all hotel staff, regardless of their hierarchy and department. A PM system is a tool to enable faster decision-making and the adoption of corrective actions, aligning the hotel's performance with its strategy and goals in a more efficient manner.

To assess the quality of the prototype, its results were evaluated from three perspectives, which were proposed as research questions:

Q1. Are there any technical issues that can limit the scope and performance of the system itself?

Q2. Do the hotels' staff identify relevant benefits from using the system?

Q3. Is it possible to identify quantifiable improvements in the hotels' performance?

One of the main objectives of this research project was the prototype instantiation, as well as the knowledge obtained from prototyping. As defended by Zheng (2009), prototyping should be considered a vehicle to learn about the problem domain, seek a solution and, finally, to create knowledge. Therefore, while trying to answer the research questions, it was anticipated that some important issues could arise during the development of the prototype, such as:

- Technical obstacles in accessing proprietary databases;
- Unavailability of data to produce some of the metrics;
- Database performance issues;
- Reluctance of the hotels' staff to use the system;
- The need for a formal hotel strategic plan.

The ultimate goal of the research project focused on the requirements, development, implementation and evaluation of a PM system to provide better

operational results and alignment of the hotel's performance with their strategy and goals.

As a consequence, the project identified the main characteristics of a PM system and the required technology concepts to implement it, such as dashboards, *Business Intelligence* (BI) and *Data Analytics* (DA). It also identified the areas of expertise in hospitality where the system could have more impact and that should be addressed during the design and development phase of the prototype, such as *Revenue Management* (RM), *Social Reputation* (SR), common hotel metrics/KPIs, supply/demand analysis, among others.

The following section presents a brief description of the literature review that was executed on the subjects of PM, BI, DA and Dashboards. After, an introduction to the methodology used and the reasons behind its selection is presented, which is followed by a section that describes the prototype development and testing. The paper ends with a section describing the technical and business perspective evaluations, followed by the conclusions.

## 2. Literature review

2.1 Performance management

In spite of the difficulty in settling for a definition (Cokins, 2009; Howson, 2007), as explained by Eckerson (2011: 25), today, PM is outlined in a very embracing way as "the combination of processes and technologies that help an organization measure, monitor, and manage its business to optimize performance and achieve goals". Yet, some authors have a different understanding and differentiate between *Performance Management* and *Performance Measurement*. Whereas some argue that *Performance Management* and *Performance Measurement* are different disciplines that follow one another in an interactive process (Lebas, 1995), others suggest that the more recent literature shows a clear tendency to merge the bodies of knowledge from the two areas (Folan and Browne, 2005).

Traditionally, *Performance Measurement* was related to systems that were primarily based on information recollected from accounting systems (Yigitbasioglu and Velcu, 2012). A turning point occurred when Kaplan and Norton (1992) introduced

"The Balanced Scorecard" (BSC) and suggested the use of both financial and non-financial metrics in performance measurement. This became essential to have a holistic performance rating of an organization (Neumann, Roberts and Cauvin, 2008), which evolved from being a system to measure important metrics to becoming *Performance Management*, "the process of managing an organization's strategy" (Cokins, 2009: 9).

Eckerson (2011), as depicted in Figure 1, suggests a framework that describes the components of PM and how it should work.

Figure 1: PM Process
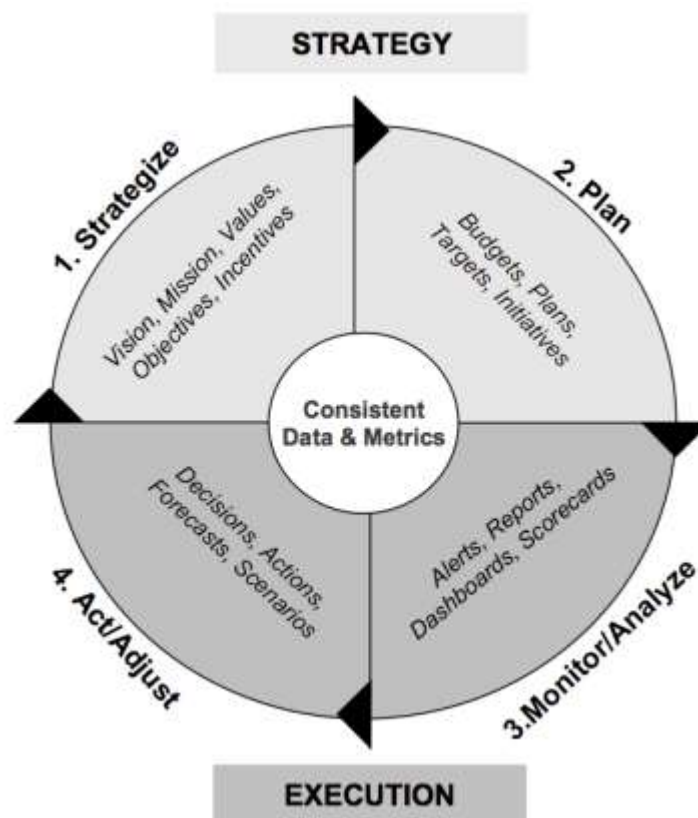
Source: Eckerson (2011: 29)

This closed-loop process turns strategy into action in four steps that revolve around integrated data and metrics that provide the vocabulary and means for measuring performance across a whole organization.

In a literature review paper related to PM in the service sector, based on 141 peer-reviewed publications from 1981 to early 2008, developed by Yasin and Gomes (2010),

the authors concluded that there was still the need for more theoretical and practical application work. From these 141 publications, only seven were from a hospitality publication, which demonstrates the relative novelty of the subject. Additionally, in another literature review paper about the state of the art in hotel performance (Sainaghi, 2010), from the 152 publications analyzed by the author, only forteen were about *Performance Measurement*.

Particularly, RM is a field where a PM system can have a great impact. In other travel industries having a system to help automate RM is already considered a mission-critical component for success (Mehrotra and Ruttley, 2006). RM is of a multi-disciplinary nature (Serra, 2013). In its genesis is the need to analyze supply and demand, historical data, strategic booking-pace, length-of-stay, cancelation/no-show and rate patterns (Serra, 2013; Mehrotra and Ruttley, 2006). All of these are data-centric tasks and processes that require inputs from multiple data sources (Serra, 2013) and the capabilities, techniques and technologies in the core of BI and DA.

The implementation of mathematical models in DA, the use of better forecasting models that can make use of all available data and new technologies (Chiang, Chen, and Xu, 2007) and the switching from intuition-based pricing decisions to analytics-based pricing (Garrow and Ferguson, 2008) are some of the referenced subjects in RM publications that could lead to effective revenue maximization. Consequently, as RM is having a more central and strategic role in hospitality, it will require better performance measurement techniques (Kimes, 2010).

Apart from RM, in other areas of the hospitality industry, BI as a tool of PM has been often cited as having an increasing importance. The use of data mining technology in Customer Relationship Management (CRM) (Danubianu and Hapenciuc, 2008), dashboards, real-time access to operational data, easier and faster identification of trends, as well as highly visual data maps (Korte, Ariyachandra, and Frolick, 2013), are topics that the most recent literature points out, towards the future of BI systems as a way to better align strategies to the organization's objectives.

The hospitality industry is becoming a leader in the use of BI, particularly in the case of major hospitality organizations. They have greatly benefited from BI and IT, even though most of them still have a long way to go (Korte et al., 2013).

Piccoli, Carroll and Hall (2011) created a model to evaluate the electronic maturity of hospitality organizations and the level at which they have systematic and analytical processes implemented to take advantage of opportunities in demand generation, multi-channel distribution and revenue optimization. This model describes, at the upper stages (4 and 5), that organizations must have fully integrated systems, with analytical capabilities to achieve a continuous learning and improvement process of optimization, which emphasizes the need for hospitality organizations to have suitable PM systems.

At the time this research took place, no specific, self-proclaimed, out-of-the-box PM system was found on the market. However, there are some generic BI and dashboard systems and also some systems related to specific fields of the hospitality industry, mainly for RM, that incorporate a lot of the capabilities and techniques a BI/PM system should have and that can be used to implement a PM system.

2.2 Business intelligence

Report and analytical tools are major features of the PM process, since these are the tools that support the strategy's execution.

Turban et al. (2010: 8, 12) describe BI as "an umbrella term that combines architectures, tools, databases, analytical tools, applications, and methodologies". The same authors state that PM is an emerging portfolio of applications and methodologies that contains evolving BI architecture in its core. For the authors, PM "extends the monitoring, measuring, and comparing of sales, profit, cost, profitability, and other performance indicators by introducing the concept of management and feedback".

2.3 Data analytics

Data Analytics (DA), similarly to other disciplines, is identified by different names like *Business Analytics* (BA), *Statistical Analysis*, *Data Mining* or simply *Analytics* (Scarisbrick-Hauser, 2007). DA is a subset of BI (Davenport and Harris, 2007: 18). These authors define DA as "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions".

Several authors like Schultz (2004) and Schläfke, Silvi and Möller (2013) have acknowledged the growing importance of DA in PM and its connection to the organization's strategy. Schläfke et al. (2013: 111) went even further and proposed a framework where they defined the relation between IT-based applications, Management/Accounting applications and analytical methods (depicted in Figure 2) as *Performance Management Analytics* - "the extensive use of data and analytical methods to understand relevant business dynamics, to effectively control key performance drivers, and to actively increase organizational performance".

Figure 2: PM Analytics
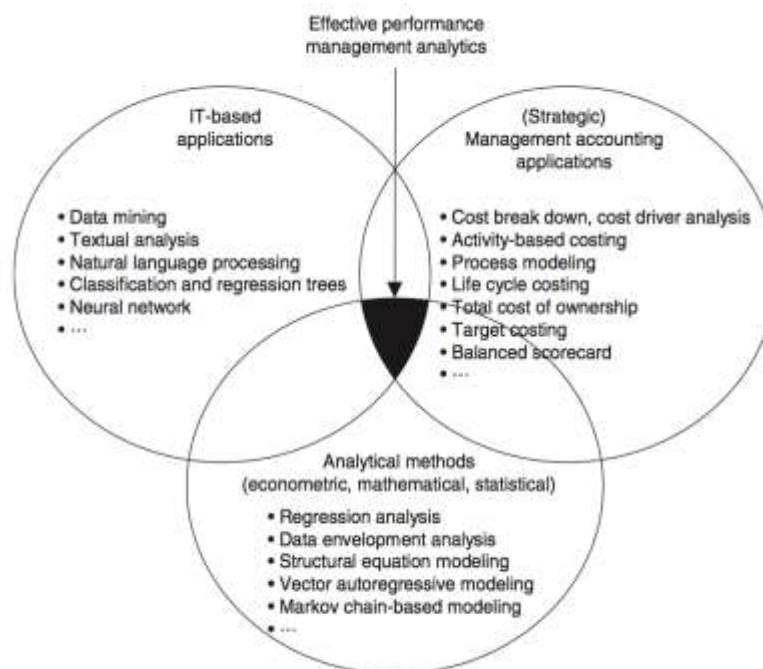
Source: Schläfke, Silvi, and Möller (2013: 114).

2.4 Dashboards

Dashboards are the visualization entry point for PM. Dashboards enable staff at all levels of the organization to view all key facts/metrics and start the exploration of the data (Schultz, 2004). Dashboards are the primary vehicle for communicating PM within the organization (Dover, 2004). When used with a powerful analytical engine, dashboards have the potential to get the right information presented to key users at the most valuable time.

Besides the definition by Few (2006) that a dashboard is a way to monitor, at a glance, the most important information needed to achieve one or more objectives, in the context of PM, Eckerson (2011: 10) deepened that definition and concept. He entitled it *Performance Dashboards* (PD) and expressed it as a layered information delivery system that parcels out information, insights, and alerts to users on demand so they can measure, monitor, and manage business performance more effectively".

According to Eckerson (2011: 10), PD should be much more than screens populated with impressive graphics. They should be "full-fledged business information systems designed to help organizations optimize performance and achieve strategic objectives". As a result, the author states that the terms "PD system" or "PM system" are equivalent and that the two are interchangeable.

According to the author, a PM system should have three significant features that he called the "three threes":

- Three applications – set of functionalities designed to fulfill specific user requirements;
- Three layers – based on the MAD (monitor, analyze and drill to detail) framework that defines how the dashboard should section information in layers;
- Three types – these types emphasize the three applications and three layers.

Implementing a PM system can have several obstacles like assuring data availability, accessibility and accuracy in a timely fashion (Lorence, 2010). Another obstacle well referenced in the literature is the design itself. An extensive list of

literature on this subject can be found in the article "A review of dashboards in Performance Management: implications for design and research" (Yigitbasioglu and Velcu, 2012).

Figure 3: MAD Framework
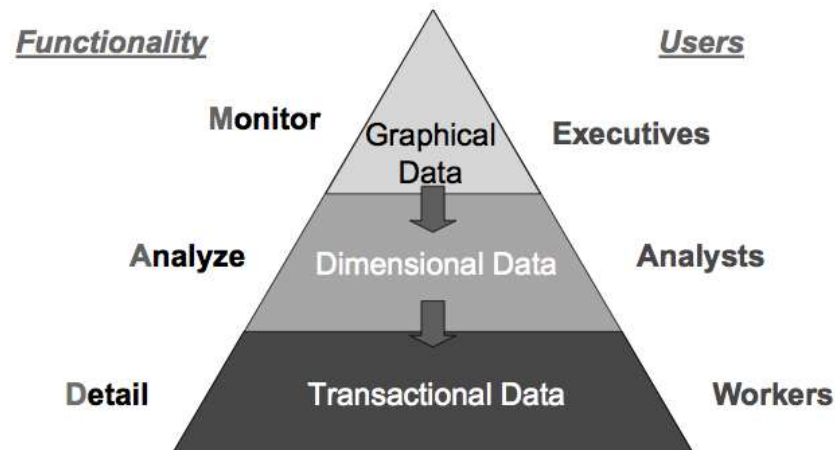
Source: Eckerson (2011: 14).

3. Methodology

3.1 Methodology selection

The need for strategic and management decisions to shift from intuition-based to analytics-based, together with the increasing requirement for performance measurement techniques to be used in the hospitality industry (Kimes, 2010) as well as the need to automate mission-critical areas, like RM, because of its data-centric and multi-disciplinary nature (Serra, 2013) call for the use of the capabilities, techniques and technologies in the core of PM, BI and DA.

Together with this need to make better, faster and information-based decisions, the acknowledged nonexistence of an out-of-the-box PM system specific to the hospitality industry, is clearly a problem that can be addressed in the context of *Design Science Research* (DSR), as it requires the development of an artifact.

In this case, the artifact would be the prototype of a software system, fulfilling the two requirements of DSR: Relevance – by addressing a real business need and

Rigor – by the need to apply the proper body of knowledge in the artifact development (Cleven, Gubler, and Hüner, 2009; Hevner et al., 2004).

Even though the main goal of the project was within the scientific area of Management, a technological approach was essential to create a fully functional prototype of the PM system for the hospitality industry. This meant that research had to be conducted also in the area of Information Systems (IS). For this reason, *Design Science Research Methodology* (DSRM) - a well-established research method in Information Systems (IS) – was used as the methodology to support the research and development of the system.

The DSRM, as defined by Peffers et al., (2007), is based on the practical guidelines defined by Hevner et al. (2004), the first and most important guideline being the "Design as an Artifact" (Peffers et al., 2007: 6). In this guideline Hevner et al. (2004: 82, 75) state that "knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact". The authors claim that DSR "requires the creation of an innovative, purposeful artifact". This artifact should be relevant to the problem "solving a heretofore unsolved problem or solving a known problem in a more effective or efficient manner" (Hevner et al., 2004: 82).

3.2   Measures, metrics and indicators identification

Measurement selection is one of the cornerstones PM system development, since its success could depend on the measurements selection made (Yigitbasioglu and Velcu, 2012), therefore a rigorous process of identification and selection of measures, metrics and indicators was carried out. This process took into account not only the scientific aspect, but also the business aspect, as the measurements needed to be accepted and be valid to the hoteliers.

In this project the terminology defined by Eckerson (2011) was adopted, not only because it is more commonly used in PM systems, but also because it's easily related to the BSC, a wide spread PM methodology already implemented in many organizations.

3.3 Development and implementation

In the scope of DSRM, having identified the need to design a system from scratch, the first phase was the definition of its architecture.

The sequence of activities, after the system's architecture was concluded, consisted in several iteration cycles, including demonstrations and evaluations with the hotels staff, to show the results in each development phase, to evaluate and redesign the project requirements according with the user's feedback.

It was expected that the full process sequence would be developed in four iteration cycles as depicted in Figure 4.

Even though there is some debate in DSRM about what should be considered an artifact in DSR (Offermann et al., 2010; Cleven et al., 2009; Beaudouin-Lafon and Mackay, 2003) the artifacts that were selected to present are both well accepted within the research community.

The first iteration artifact was the *Software Requirements Specification* (SRS) document considered a "model" and on the subsequent iterations, the prototype, classified as an "instantiation", a concrete representation of that model, was the resulting artifact.

4. Prototype development and testing

4.1 Iteration 1

To answer the research questions a prototype was developed with the intention of testing its features with the collaboration of a group of hotels that agreed to facilitate data for evaluation purposes, so inputs in terms of adequacy and consistency could be gathered. However, for the objective of this iteration the definition of the SRS document and its approval by the hotels was crucial for their commitment to participate in the project, as well as for any requisite changes that they wanted to include.

Figure 4: System concept diagram
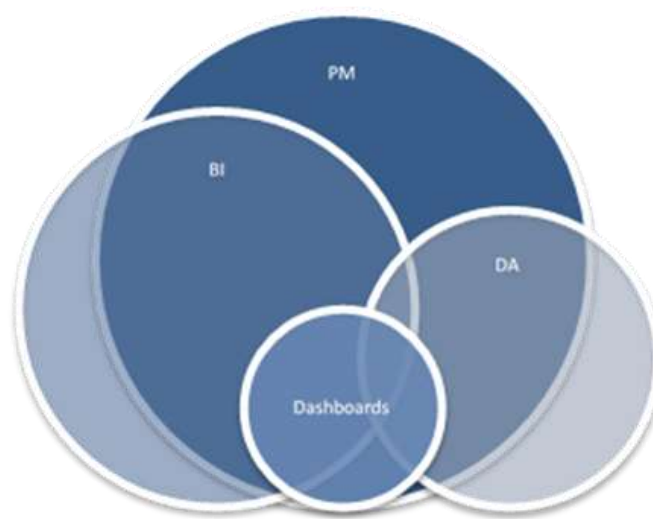
Source: Authors.

As can be seen in at the center and as the core of the system (prototype), is the dashboard, which corresponds to the "Monitor" layer of the MAD Framework. BI and DA capabilities, techniques and processes, are the foundations that makes it possible to deliver the dashboards, but also makes information available for analysts and the organization's staff for analysis and consultation, which are the other 2 layers of the MAD Framework: the "Analyze" and "Detail" functionalities. Altogether, these three layers encompassed by the combination of processes - a fundamental component of PM - act as a catalyst for organizations to optimize their performance and achieve goals, which is the ultimate objective of a PM system.

As concluded by Yigitbasioglu and Velcu (2012: 42) a "dashboard is expected to collect, summarize, and present information from multiple sources…", but "as data is concerned, the dashboard represents the tip of an iceberg". Data is the base of any PM system. Eckerson (2011) identified eight types of data architectures that could be employed in the construction of PM systems. For this project mainly because the simplification of the deployment process and the need for almost not having to install hardware or software, the "cloud" architecture was selected.

Table 1: Data sources

Data source	Type	Origin[1]
Property Management System (PMS)	Primary	Internal
Accounting/Financial	Primary	Internal
Weather (historic and forecast)	Secondary	External
Social reputation – own hotel and competitive intelligence	Secondary	External
Prices and inventory – competitive intelligence	Secondary	External
Market – supply and demand	Secondary	External

Source: Authors.

In this iteration, based on the identified metrics and indicators, and the expressed selection criteria, it was necessary to determine the data sources that could provide the required data, because, as recognized by several authors, PM and dashboards require the use of multiple data sources (Serra, 2013; Yigitbasioglu and Velcu, 2012; Eckerson, 2011; Cokins, 2009; Pauwels et al., 2009; Rasmussen, Chen, and Bansal, 2009). These data sources could be of different types (primary and secondary) and origins (internal or external) (Korte et al., 2013; Turban, Sharda, and Delen, 2011; Venkatraman and Ramanujam, 1986). The data sources identified as indispensable are portrayed in Table1.

The demonstration of the artifact (mainly the SRS document) in this iteration had the objective of legitimizing it, which is a DSR valid evaluation function (Cleven et al., 2009: 19), as it "enables a traceable documentation of inputs and outcomes of the artifact construction process".

This first demonstration activity was a key task and played an important role in the project's success, as it represented the first introduction of the project to the hotels.

---

[1] Internal data sources were considered the ones that were owned by the hotel and were in internal servers/documents. All data not owned by the hotels or available on servers/documents from third parties were considered external. Because the hotel does not own them, secondary/external data sources require a correct procurement and quality evaluation process.

This iteration was critical since without the hotels' participation it would not be possible to access the internal data sources nor could a proper assessment of the prototype be done, possibly resulting in the project's closure.

However, some requisites for the selection of hotels that would be invited to participate in the project had to be established, i.e.:

- Business dimension;
- Internal accounting department;
- Used InovGuest PMS[2] and Primavera ERP[3];
- Geographic proximity and accessibility;
- Easy access to the IT team or to the companies who provided IT support;
- Familiarity with the management team.

In accordance with the established criteria, the hotels described in Table 2 were selected.

The demonstration activity, in this first iteration, consisted of the presentation to the hoteliers, in one-to-one meetings, of the SRS document (artifact) with a walkthrough on the main topics.

At the moment of the demonstration/presentation of the project, embodied in the SRS document, all hotels showed a very high degree of interest in participating in the project. Nevertheless, none confirmed the participation "on the hour". It took almost two weeks until there was written confirmation of the participation of all four hotels.

No hotel asked for any changes in the SRS document and unanimously showed enthusiasm about the project. However, H3 and H4 revealed some apprehension about the planned period prototype evaluation in the production environment (high season).

---

[2] InovGuest PMS: Property Management System produced in Portugal by Wareguest (www.wareguest.com).
[3] Primavera ERP: Enterprise Resource Planning system produced in Portugal by Primavera BSS (www.primaverabss.com).

Table 2: List of selected hotels

Identification	Type	Characteristics
H1	Touristic apartments ****	86 apartments in mixed-ownership (part in timeshare), with interior and exterior pools, meeting rooms, gym, one bar and one restaurant (explored by a third party).
H2	Hotel ****	180 rooms, with meeting rooms, SPA, exterior pool, gym, one bar and one restaurant.
H3	Apartments hotel ****	158 rooms, with meeting rooms, exterior pool, one bar and one restaurant (just for breakfasts).
H4	Apartments hotel *****	22 rooms, 2 suites and 80 apartments in mixed-ownership (part in fractional ownership) with meeting rooms, SPA, interior and exterior pools, tennis court, gym, two bars and one restaurant.

Source: Authors.

4.2 Iterations 2, 3 and 4

The following iterations were all about the incremental "delivery" of functionalities (detailed in Figure 5). In DSRM, as in Agile[4], requirements prioritization and incremental delivery in each iteration is recognized as a way to deliver to users, therefore it was essential to identify the functionalities that the hotels valued the most as soon as possible (Ratcliffe and McNeill, 2012; Racheva et al., 2010; Cao and Ramesh, 2008).
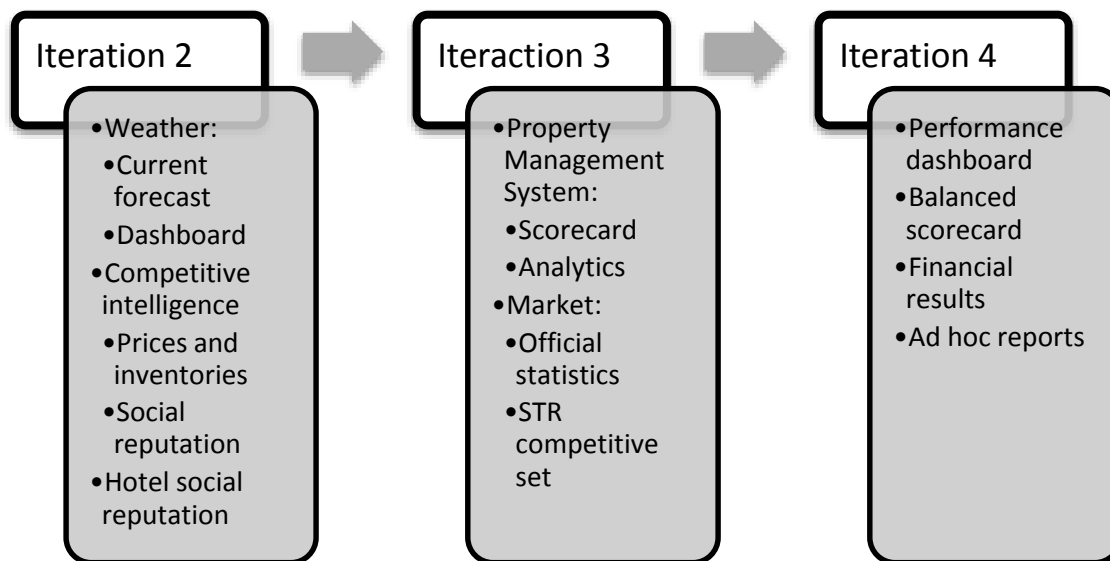
This incremental delivery of functions made possible for the hotels to use the system even before it was fully completed, which in turn, facilitated obtaining users feedback.

At the end of each iteration development activity, a demonstration was made to each hotel and the results of the iteration evaluated, so that they could be used as feedback for the following iteration and the project overall assessment.

After the evaluation activity of the last iteration, as defined by DSRM, was initiated the communication activity.

---

[4] Commonly used software development methodology.

Figure 5: Functionalities delivered by iteration

Iteration 2
- Weather:
- Current forecast
- Dashboard
- Competitive intelligence
- Prices and inventories
- Social reputation
- Hotel social reputation

Iteration 3
- Property Management System:
- Scorecard
- Analytics
- Market:
- Official statistics
- STR competitive set

Iteration 4
- Performance dashboard
- Balanced scorecard
- Financial results
- Ad hoc reports

Source: Authors.

5. Evaluation

To obtain results that could be used to answer the project's initial questions, although Peffers et al. (2007) advocates that conceptually evaluation could include any empirical evidence or logical proof, it was decided to use a set of different methods based on the definitions by Hevner et al. (2004) and common evaluation methods used in *Interaction Design* (Sharp, Rogers, and Preece, 2009):

Observational:

- Field study: the use of the prototype in the participating hotels was monitored, using group interviews (in activity "(4) Demonstration" of each iteration), but also logged information on the prototype usage (from activity "(5) Evaluation" of iteration 2 onwards).

Analytical:

- Dynamic analysis: by logging database operations, website use, agents errors and server work variables, the performance, reliability and availability of the prototype was monitored (from activity "(5) Evaluation" of iteration 2 onwards);

- Heuristic evaluation: by asking four experts[5] to conduct a heuristic evaluation of the prototype (in activity "(5) Evaluation" of iteration 4).

Experimental:

- Controlled experiment: using the development environment to test and identify problems with the artifact (since activity "(3) Design and development" of iteration 2 onwards).

Testing:

- Functional testing: undertaken by the prototype's developers to identify failures and defects (since activity "(3) Design and development" of iteration 2 onwards).

The results of the application of the different evaluation methods helped answer the research questions.

To better interpret the results, they are presented from two different perspectives: technical and business.

5.1 Technical perspective

Here, the system's technical results and their relevance to answer the research questions are interpreted, mainly "Q1 - Are there any technical issues that can limit the scope and performance of the system itself?"

In the design of the system three main technical objectives were established:

1. Evaluate potential problems with data accessibility and availability;

2. Understand potential problems with data quality;

3. Test the performance of the cloud environment.

As Eckerson (2011) and Cokins (2009) stated, data is at the center of all PM processes. Assuring data is available, accessible and accurate in a timely manner is critical for a dashboard (Lorence, 2010), thus, validating technical objectives 1 and 2 was very important for the outcome of this project.

---

[5] As presented by Sharp, Rogers and Preece (2009) a set of three to five experts is considered representative.

Even though some issues were found, it's possible to infer that the two first technical objectives, about the data sources, were achieved. The results also demonstrated that the third objective, the system's test in a cloud environment was also achieved with excellent results. The results showed that, by using an agents-based architecture and a resilient distributed computing platform, as defined by Svobodova (1984), the main requisites for the SaaS/cloud based system (fault tolerance, load balancing, among others) (Rimal, Choi, and Lumb, 2009) were also achieved.

5.2 Business perspective

Here, the results are interpreted from the business/management perspective, mainly to answer the research questions: "Q2 - Does the hotel staff identify the benefits of using the system?" and "Q3 - Is it possible to identify quantifiable improvements in the hotel's performance?"

Regarding Q2, from a qualitative approach, based on what was declared by the users in the group interviews and from what was observed, considerable benefits were identified.

Although users recognized that during the evaluation period the main areas where they got benefits from were SR and CI, they acknowledge that bigger and better benefits could be obtained by using the system's analytic features to recognize trends and patterns, in the different customer segments.

Users confirmed that the fact that the system brought SR and CI information to them in an easier and more accessible way than they previously had. This together with the hotels' increasing comprehension of the importance that SR (Abdelfattah, 2013; Anderson, 2012; Callarisa et al., 2012; Öğüt and Onur Taş, 2012; Sparks and Browning, 2011) and CI (Chen and Schwartz, 2013; Hayes and Miller, 2011; Enz and Canina, 2010) have in today's hospitality performance, contributed as recognized by the users and registered by the logs, for SR and CI pages to be the most visited and where most time was spent.

Moreover, in the group interviews the users recognized that they did not take advantage of the full potential of the system. They recognized that the system could be used to execute better forecasts, better marketing plans and also, define budgets and communicate those budgets/goals to every hotel department. This reveals that they understood what information could be obtained from the system and how to make good use of it.

Despite the increasing importance that benchmarking has, as a tool to assess the performance of organizations, particularly in hospitality and tourism (Battersby, 2006; Kozak and Nield, 2001; Pyo, 2001), the results show that both the pages on market supply and demand benchmarking (official entities and STR) where among the least visited and used. However, this by itself does not mean that users do not consider it of importance. As these metrics/indicators are updated only once a month, there is not much need to constantly verify them, at least according to what was reported by the users.

The same cannot be said for weather options and the ad hoc reports. If for the weather pages, at least one hotel said that they should be taken out of the system considering it unnecessary (contradicting the importance of weather in the economic performance of the hotels as presented in section 3), for the ad hoc reports page, the fact that it was not much used, is related to the fact that it required more training and was only available in the last iteration, when most of the users did not have the time to use the system for more analytical and time consuming tasks, nor did they have time for better training.

6. Conclusions

Looking at the system as an integrated and comprehensive solution, designed in accordance with DSRM (Peffers et al., 2007) to address an unsolved problem in a unique and innovative way (Hevner et al., 2004), it is possible to say that the objective of confirming the viability of developing a commercial service was achieved.

Since no layered information system specific for the hospitality industry, allowing users to measure, monitor and manage business performance, thus enabling faster and better information-based decisions, was found on the market, it was decided to

build a prototype to assess the system suitability to address this "problem" (March and Storey, 2008).

Even though the system's complexity required a long development period and the academic calendar caused constraints on the time to evaluate the prototype in hotels, it was decided that the evaluation in "real conditions" would be beneficial to accomplish the research objective, even if that meant having a short evaluation period, in the high season.

The implementation and evaluation of the prototype in four hotels confirmed the fulfillment of the two fundamental requirements a DSR artifact should have: relevance and rigor. Relevance, by addressing a real business need and rigor, by appropriately applying the existing body of knowledge (Cleven et al., 2009; Hevner et al., 2004).

The prototype enabled hotels not only to have access to dashboards with timely key metrics/indicators from different data sources (operational, financial, social reputation, competitive intelligence, market benchmarking and weather) and, from a single system, measure and monitor the hotels performance, but also provided analytical capabilities, essential for performance optimization and strategic objectives persecution (Eckerson, 2011; Davenport and Harris, 2007).

The results obtained from the prototype evaluation in the hotels strongly supported the system's viability in the three initially defined perspectives.

Moreover, the overall results complemented by the request of all the participating hotels to continue to use the prototype and their willingness to pay for a commercial service that provides the same information as the prototype, confirmed its commercial viability. Furthermore, the project also created an appealing by-product, the hotels' dimensional databases, that can be used in other systems (e.g. Central Reservation Systems, Revenue Management Systems or Self-Service BI systems), thus leveraging their potential.

In addition, this project also confirmed, as challenged by van Aken (2005, 2004), that technologic solution-oriented research, based in the design sciences, can be used to solve relevant problems in Management.

6.1 Limitations and recommendations

Despite being possible to conclude that the system is viable from the technical and market acceptance perspectives, from an economic viability perspective, since that was outside the scope, further research is required to determine it, probably with the elaboration of a business plan.

However, even from the technical aspect, to translate this prototype to a commercial service, the evaluation revealed that there are still some situations that should be implemented or revised, namely:

- Users should be able to create their own metrics/indicators and define where they want to put them on their personal dashboard and BSC;

- Users should be able to create and program visual or email alerts based on the behavior of metrics/indicators;

- Inclusion of forecast and "what-if scenarios" that with the use of the different data sources data can help users do better planning.

References

ABDELFATTAH, M. (2013). A Comparison of Several Performance Dashboards Architectures. *Intelligent Information Management*, *5*(2), 35-41. Doi: 10.4236/iim.2013.52005

ANDERSON, C. K. (2012). The Impact of Social Media on Lodging Performance. *Cornell Hospitality Report*, *12*(15), 4-11.

BATTERSBY, D. (2006). Importance of Benchmarking. *Caterer & Hotelkeeper*, *196*(4449), 18.

BEAUDOUIN-LAFON, M., & MACKAY, W. (2003). Prototyping Tools and Techniques. In J. A. Jacko & A. Sears (Eds.), *The Human-Computer Interaction Handbook* (pp. 1006-1031). Hillsdale, NJ, USA: L. Erlbaum Associates.

CALLARISA, L., GARCÍA, J. S., CARDIFF, J., & ROSHCHINA, A. (2012). Harnessing Social Media Platforms to Measure Customer-Based Hotel Brand Equity. *Tourism Management Perspectives*, *4*, 73-79. Doi: 10.1016/j.tmp.2012.04.005

CAO, L., & RAMESH, B. (2008). Agile Requirements Engineering Practices: An empirical study. *Software, IEEE*, *25*(1), 60-67. Doi: 10.1109/MS.2008.1

CHEN, C.-C., & SCHWARTZ, Z. (2013). On Revenue Management and Last Minute Booking Dynamics. *International Journal of Contemporary Hospitality Management*, *25*(1), 7-22. Doi: http://dx.doi.org/10.1108/09596111311290192

CHIANG, W.-C., CHEN, J. C. H., & XU, X. (2007). An Overview of Research on Revenue Management: Current Issues and Future Research. *International Journal of Revenue Management*, *1*(1), 97-128. Doi: 10.1504/IJRM.2007.011196

CLEVEN, A., GUBLER, P., & HÜNER, K. M. (2009). Design alternatives for the Evaluation of Design Science Research Artifacts. In *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology* (pp. 19:1-19:8). New York, NY, USA: ACM. Doi: 10.1145/1555619.1555645

COKINS, G. (2009). *Performance Management: Integrating Strategy Execution, Methodologies, Risk, and Analytics*. Hoboken, NJ, USA: John Wiley & Sons.

DANUBIANU, M., & HAPENCIUC, V. C. (2008). Improving Customer Relationship Management in Hotel Industry by Data Mining Techniques. *Annals of the University of Craiova, Economic Sciences Series*, *7*(36), 3261-3268.

DAVENPORT, T. H., & HARRIS, J. G. (2007). *Competing on Analytics: The new Science of Winning*. Boston, MA, USA: Harvard Business School Press.

DOVER, C. (2004). How Dashboards can Change your Culture. *Strategic Finance*, *86*(4), 43-48.

ECKERSON, W. W. (2011). *Performance Dashboards Measuring, Monitoring, and Managing your Business,* (2nd ed.). Hoboken, NJ, USA: John Wiley & Sons.

ENZ, C. A., & CANINA, L. (2010). Competitive Pricing in European Hotels. In J. S. Chen (Ed.), *Advances in Hospitality and Leisure* (pp. 3-25). Emerald Group Publishing Limited. Doi: 10.1108/S1745-3542(2010)0000006005

FEW, S. (2006). *Information Dashboard Design*. Sebastopol, CA, USA: O'Reilly.

FOLAN, P., & BROWNE, J. (2005). A Review of Performance Measurement: Towards Performance Management. *Computers in Industry*, *56*(7), 663-680. Doi: 10.1016/j.compind.2005.03.001

GARROW, L., & FERGUSON, M. (2008). Revenue Management and the Analytics Explosion: Perspectives from Industry Experts. *Journal of Revenue & Pricing Management*, *7*(2), 219-229. Doi: 10.1057/rpm.2008.3

HAYES, D. K., & MILLER, A. A. (2011). *Revenue Management for the Hospitality Industry*. Hoboken, NJ, USA: John Wiley & Sons.

HEVNER, A. R., MARCH, S. T., PARK, J., & RAM, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75-105.

HOWSON, C. (2007). *Successful Business Intelligence: Secrets to making BI a killer app*. New York, NY, USA: McGraw-Hill Education.

KAPLAN, R. S., & NORTON, D. P. (1992). The Balanced Scorecard - Measures that drive Performance. *Harvard Business Review*, (January-February), *70*(1), 70-79.

KIMES, S. E. (2010). The Future of Hotel Revenue Management. *Cornell Hospitality Reports*, *10*(14), 6-15.

KORTE, D., ARIYACHANDRA, T., & FROLICK, M. (2013). Business Intelligence in the Hospitality Industry. *International Journal of Innovation, Management and Technology*, *4*(4), 429-434. Doi: 10.7763/IJIMT.2013.V4.435

KOZAK, M., & NIELD, K. (2001). An Overview of Benchmarking Literature: Its Strengths and Weaknesses. *Journal of Quality Assurance in Hospitality & Tourism*, *2*(3-4), 7-23. Doi: 10.1300/J162v02n03_02

LEBAS, M. J. (1995). Performance Measurement and Performance Management. *International Journal of Production Economics*, *41*(1-3), 23-35. Doi: 10.1016/0925-5273(95)00081-X

LORENCE, M. J. (2010). Using Dashboards to Revolutionize your Performance Management System. *Balanced Scorecard Report*, *12*(2). Harvard Business Review. Retrieved from http://hbr.org/product/using-dashboards-to-revolutionize-your-performance/an/B1003C-PDF-ENG

MARCH, S. T., & STOREY, V. C. (2008). Design Science in the Information Systems discipline: An Introduction to the Special Issue on Design Science Research. *MIS Quarterly*, *32*(4), 725-730.

MEHROTRA, R., & RUTTLEY, J. (2006). *Revenue Management,* (2nd ed.). Washington, DC, USA: American Hotel & Lodging Association (AHLA).

NEUMANN, B., ROBERTS, M. L., & CAUVIN, E. (2008). Financial and Nonfinancial Performance Measures. *Cost Management*, *22*(November/December), 5-14.

OFFERMANN, P., SOREN, B., SCHONHEEE, M., & BUB, U. (2010). Artifact Types in Information Systems Design Science – A Literature Review. In R. Winter, J. L. Zhao, & S. Aier (Eds.),

Global perpectives on Design Science research (Vol. 6105, pp. 77-92). Heidelberg, Germany: Springer-Verlag Berlin. Doi: 10.1007/978-3-642-13335-0_6

ÖĞÜT, H., & ONUR TAŞ, B. K. (2012). The Influence of Internet Customer Reviews on the Online Sales and Prices in Hotel Industry. *The Service Industries Journal*, *32*(2), 197-214. Doi: 10.1080/02642069.2010.529436

PAUWELS, K., AMBLER, T., CLARK, B. H., LAPOINTE, P., REIBSTEIN, D., SKIERA, B., WIERENGA, B., WIESEL, T. (2009). Dashboards as a Service: Why, What, How, And What Research is Needed? *Journal of Service Research*, *12*(2), 175-189. Doi: 10.1177/1094670509344213

PEFFERS, K., TUUNANEN, T., ROTHENBERGER, M. A., & CHARTTERJEE, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45-77. Doi: 10.2753/MIS0742-1222240302

PICCOLI, G., CARROLL, B., & HALL, L. (2011). Network Exploitation Capability: Mapping the Electronic Maturity of Hospitality Enterprises. *Cornell Hospitality Report*, *11*(18), 6-14. Retrieved from
https://www.hotelschool.cornell.edu/chr/pdf/showpdf/1473/chr/research/piccolicarroll.pdf

PYO, S. (2001). *Benchmarks in Hospitality and Tourism*. Binghamton, NY, USA: Haworth Hospitality Press.

RACHEVA, Z., DANEVA, M., HERRMANN, A., & WIERINGA, R. J. (2010). A Conceptual Model and Process for Client-Driven Agile Requirements Prioritization. In *2010 Fourth International Conference on Research Challenges in Information Science (RCIS)* (pp. 287-298). France: Nice. Doi: 10.1109/RCIS.2010.5507388

RASMUSSEN, N., CHEN, C. Y., & BANSAL, M. (2009). *Business Dashboards: A Visual Catalog for Design and Deployment*. Hoboken, NJ, USA: John Wiley & Sons.

RATCLIFFE, L., & MCNEILL, M. (2012). *Agile Experience Design a Digital Designer's Guide to Agile, Lean, and Continuous*. Berkeley, CA, USA: New Riders.

RIMAL, B. P., CHOI, E., & LUMB, I. (2009). A Taxonomy and Survey of Cloud Computing Systems. In *Fifth International Joint Conference on INC, IMS and IDC, 2009. NCM '09* (pp. 44-51). Korea: Seoul. IEEE. Doi: 10.1109/NCM.2009.218

SAINAGHI, R. (2010). Hotel Performance: State of the Art. *International Journal of Contemporary Hospitality Management*, *22*(7), 920-952. Doi: http://dx.doi.org/10.1108/09596111011066617

SCARISBRICK-HAUSER, A. (2007). Data Analysis and Profiling. *Direct Marketing: An International Journal*, *1*(2), 114-116. Doi: http://dx.doi.org/10.1108/17505930710756860

SCHLÄFKE, M., SILVI, R., & MÖLLER, K. (2013). A Framework for Business Analytics in Performance Management. *International Journal of Productivity and Performance Management*, *62*(1), 110-122. Doi: http://dx.doi.org/10.1108/17410401311285327

SCHULTZ, G. J. (2004). Enterprise Performance Management: Strategic Decision Analytics from Deep Data. *Information Strategy: The Executive's Journal*, *20*(3), 14-24.

SERRA, F. (2013). Estratégias de negócio: Os Conceitos de Yield e de Revenue Management e a sua Aplicação às Operações Hoteleiras. In C. Henriques, I. Monteiro, F. Serra, J. Santos, & P. Águas (Eds.), *Inovação e Qualidade na Hotelaria* (pp. 161-172). Faro, Portugal: Universidade do Algarve, Escola Superior de Gestão, Hotelaria e Turismo.

SHARP, H., ROGERS, Y., & PREECE, J. (2009). *Interaction Design: Beyond Human - Computer Interaction,* (2nd ed.). Chichester, West Sussex, U.K: John Wiley & Sons.

SPARKS, B. A., & BROWNING, V. (2011). The Impact of Online Reviews on Hotel Booking Intentions and Perception of Trust. *Tourism Management*, *32*(6), 1310-1323. Doi: 10.1016/j.tourman.2010.12.011

SVOBODOVA, L. (1984). Resilient Distributed Computing. *IEEE Transactions on Software Engineering*, *SE-10*(3), 257-268. Doi: 10.1109/TSE.1984.5010234

TURBAN, E., SHARDA, R., & DELEN, D. (2011). *Decision Support and Business Intelligence Systems (*9th ed.). New Jersey, NJ, USA: Prentice Hall.

TURBAN, E., SHARDA, R., DELEN, D., & KING, D. (2010). *Business Intelligence: A Managerial Approach, (*2nd ed.). Boston, MA, USA: Prentice Hall.

VAN AKEN, J. E. (2004). Management Research Based on the Paradigm of the Design Sciences: the Quest for Field-Tested and Grounded Technological Rules. *Journal of Management Studies*, *41*(2), 219-246. Doi: 10.1111/j.1467-6486.2004.00430.x

VAN AKEN, J. E. (2005). Management Research as a Design Science: Articulating the Research Products of Mode 2 Knowledge Production in Management. *British Journal of Management*, *16*(1), 19-36. Doi: 10.1111/j.1467-8551.2005.00437.x

VENKATRAMAN, N., & RAMANUJAM, V. (1986). Measurement of Business Performance in Strategy Research: A Comparison of Approaches. *Academy of Management Review*, *11*(4), 801-814. Doi: 10.5465/AMR.1986.4283976

YASIN, M. M., & GOMES, C. F. (2010). Performance Management in Service Operational Settings: a Selective Literature Examination. *Benchmarking: An International Journal*, *17*(2), 214-231. Doi: http://dx.doi.org/10.1108/14635771011036311

YIGITBASIOGLU, O. M., & VELCU, O. (2012). A Review of Dashboards in Performance Management: Implications for Design and Research. *International Journal of Accounting Information Systems*, *13*(1), 41-59. Doi: 10.1016/j.accinf.2011.08.002

ZHENG, G. (2009). *A Multidimensional and Visual Exploration Approach to Project Portfolio Management*. Georgia, USA: Georgia State University.

NUNO ANTÓNIO is R&D Director at WareGuest, a software development company specialized in hospitality and retail industries. He is also an invited professor at the School of Management, Hospitality and Tourism of the University of the Algarve, Portugal. He holds a Computer Science Engineering degree, a Masters in Hotel Administration and Management, and certifications in Business Analytics and Project Management. Endereço institucional: Universidade do Algarve, Escola Superior de Gestão, Hotelaria e Turismo, Campus da Penha, 8005-117 Faro, Portugal.

FRANCISCO SERRA is a professor at the School of Management, Hospitality and Tourism of the University of the Algarve, Portugal. He holds a degree in Marketing and a PhD in Economics and Management, besides being a Certified Hotel Manager with professional experience in hospitality, healthcare and higher education management. His research interests vary from operations research, systems dynamics, performance optimization and strategy to tourism destination management and regional economics. He has authored and edited several books and book chapters, and has presented and published more than 50 research papers, some of them in co-authorship. Presently, he coordinates two funded research projects, one of them international. Endereço institucional: Universidade do Algarve, Escola Superior de Gestão, Hotelaria e Turismo, Campus da Penha, 8005-117 Faro, Portugal.