Evaluation of Statistical Machine Learning Methods and Service Design Techniques Applications in Hotel Industry

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ARTICLE INFO	Abstract
Keywords: BPM; Statistical Machine Learning; Decision-making; Service Design; Hotel Industry. **(JAAUTH)** **Vol.25 , No.1 ,** **(2023),** **pp.38 – 67.**	Business process management (BPM) is an essential discipline for any organization hoping to find creative answers to challenging business issues and provide fresh chances for progress and competitive advantage. Using service design techniques and statistical methods (SMs) as supporting tools for BPM initiatives in hotel industry is not always expressed in management literature and their mutual relations with quality management objectives are not provided, which implies difficulties when to put the notion of service process into practice. The study aims to integrate statistical methods (SMs) in BPM initiatives deployed in hotels and providing insights on the relevant statistical techniques of improving decisions-making process and how these reasons mutually relate to quality management practices in hotels. Through a comprehensive qualitative and quantitative study that included in-depth semi-structured interviews with five-star hotel managers in Egypt, the authors have attempted to investigate this understudied topic. The study concluded that the level of coverage of BPM core areas is low in hotel industry and there is a need to support BPM approach with appropriate tools and techniques, especially statistical methods that are necessary to better manage service quality and performance of operation processes.

1. Introduction

Nowadays, business process (BP) is a very important concept for all businesses with different purposes in order to secure the competitive position of organizations in the market (Castro et al., 2020; Chalupa et al., 2021; Ubaid and Dweiri, 2020). One of the most modern and successful methods for managing a company's business that focuses on increasing the effectiveness of its key business processes (BPs) is to view the organization as a collection of cross-functional processes (Xuhua et al., 2018; de Morais et al., 2014; Trkman, 2010). BPM primarily focuses on controlling all of the company's value-generating operations to guarantee that processes can deliver important benefits to customers (Nolle et al., 2022; vom Brocke and Mendling, 2018; Hernaus et al., 2016; Ohtonen and Lainema, 2011). Thus, Xuhua

et al., 2018; Skobkin et al., (2017); Krstic et al., (2015) and Krstic et al., (2012) referred to the process-based approach as one of necessary structural elements of a hotel management system in an effort to modernize the classical hotel management structural model through detailed documentation, implementation and continuous improvement of relevant business processes to be effective in facing global competitive challenges.

The authors Kowalik and Klimcka-Tatar, (2018) and Ehlers et al., (2006) demonstrate the role of considering organization activities and customer services as processes to achieve effective organization designs that depict interrelated activities as actual steps, tasks and mechanisms that are necessary for service delivery to occur, and implemented to satisfy customer requirements. Service process design is the first step in service execution where all product and/or service attributes that contribute value to customer and lead to guest satisfaction need to be addressed and properly shaped using accurate information (Kusak and Gurel, 2015; Goldstein et al., 2002). As a result, poor process planning will not allow appropriate execution and inevitably lead to errors during the delivery of service (Griffin, 2013; Globerson and Zwikael, 2002). In hospitality industry, Foris et al., (2020); Kozak and Gurel, (2015); Arnold, (2013) and Victorino et al., (2005) referred that it has become a significant issue for hotel managers to continuously rethink about customers` preferences and redesign services in line with those preferences prior to the addition of new services to offer a unique valuable service for customers, exact requests of interested parties and maximize the interests of different stakeholders.

According to Rospocher et al., (2014); Aldin and de Cesare, (2011); Aldin and de Cesare, (2009); List and Korherr, (2006) and Wohed et al., (2006), there are many tools and techniques presented in management literature that can be used to design business processes and plan performance features. However, there are no specific studies conducted on hotel industry in particular to investigate the actual use of these tools and techniques by hotel managers to design hotel operation processes and determine the critical quality characteristics of the service provided. This was the motivation for the current study to investigate this under-studied topic and determine the techniques and methods used by hotel managers to design service process and develop standard operating procedures (SOPs) of hotel operation activities.

In the same context, Kirchmer, (2017) and Optiz et al., (2014) referred that business processes (BPs) associated with 21st century products and/or services are significantly more complex, necessitating numerous administrative duties and activities to coordinate and supervise company operations as required. Hence, managing business processes necessitates the use of a set of appropriate management tools and techniques to ensure that they are configured, measured, managed, and controlled in a specific manner, allowing the service provider to be proactive in identifying service quality issues and improving quality outputs. (Helmold and Samara, 2019; Goh, 2014; Aguilar-Saven, 2004). To attain a high level of performance in essential business processes and identify possible chances for enhancing quality outcomes and business operational performance, Hoerl and Snee, (2020); Sharma and Kharub, (2014) and Thor et al., (2007) referred that is necessary to use appropriate statistical

approaches and tools based on a complete knowledge of statistical background enable managers to monitor performance outcomes and analyze business results.

According to O'Mahony, (2017); Maxwell et al., (2017) and Reis et al., (2006), the application of statistical methods (SMs) is the logical way and ideal solution to overcome the problems associated with immediate errors detection and enhancing business performance. Machine learning refers to a broad collection of mathematical and statistical approaches that have been widely used in a variety of fields to solve complicated issues that are difficult to solve utilizing computer technologies (Bargarai et al., 2020; Crown et al., 2015; Hastie et al., 2009). Therefore, the study aims to answer the following questions:

1- What is hotel managers 'perception of BPM approach?
2- What are the actual use of statistical machine learning methods and service design techniques in hotels?
3- Are managers in Egyptian hotels aware of statistical machine learning and service design techniques as a basic tool of business control and improvement, and what are the application areas of these methods inside hotels?
4- What are traditional tools and techniques used by hotel managers for service process design and managing business performance?
5- What are the obstacles of using statistical machine learning methods and service design techniques in hotels?

To answer study questions, the top hotel managers were contacted in this regard, and after much discussion, their viewpoints were extracted and condensed. Through a thorough qualitative and quantitative study that included in-depth semi-structured interviews with five-star hotel managers in Egypt, the authors have sought to address this understudied topic. The paper is structured as following: Section 2 presents a comprehensive literature review on the specific area of research and related topics, Section 3 contextualize the research methods that have been utilized in order to collect required data aiming to provide answers to the research questions. Section 4 describes research results and findings with a relevant discussion extracted after analyzing the collected data from the interviews.

2. Literature Review

The hotel industry is meant to provide accommodation and all amenities and entertainment for travelers and the others (Chen, 2013). Nowadays, it becomes difficult for hotels to gain a competitive edge and raise satisfaction of their customers at the target rate because all differentiation terms of physical features, service types and actual delivery become similar among hotels (Kusak and Gurel, 2015; Lu et al., 2015; Briggs et al., 2007; Victorino et al., 2005). According to Mubiri, (2016); Kusak and Gurel, (2015); Mohsin and Lockyer, (2010) and Nurminen, (2007), there are two main strategies that hotels can be adopted to gain a competitive advantage, which are: (**a**) applying of pricing discounts; and (**b**) increasing quality of service by providing valuable benefits to customers.

Based on studies conducted by Krstic et al., (2015); Ramanthan, (2012); Reisinger et al., (2001) and Victorino et al., (2005) price strategy are no more attractive method for service

differentiation as customers seek the options provide the best value in delivery without mistakes or delays even when they pay less than the previous purchasing prices in order to be satisfied. Malik et al., (2020); Al-Ababneh, (2016); Bisgaard, (2008) and Ninemeier and Perdue, (2005) stated that customers should not have to make a choice between price and quality and organizations must learn how to manage quality with a goal of reducing defects and making the product and/or service more efficient and no guest-related complaints is recorded when guest service processes are put in place. Therefore, if a hotel fails to meet its customers' expectations and demands, customers will look for better services elsewhere (Jana and Chandra, 2016; Rauch et al., 2015; Mubiri, 2016; Sim et al., 2006).

Relating to what stated above that delivering high-quality service meet customers' needs and fit their use becomes an important way to success, Szelagowski and Berniak-Wozny, (2020); Dumas et al., (2018) and Batista et al., (2008) referred that interest in business process management (BPM) was fueled by the need to develop the ability to respond promptly to customers` needs and improve the quality of products and/or services through transforming isolated efforts into cross-functional activities can be integrated and measured for value creation. Many authors (Segatto et al., 2013; Kumar et al., 2008; Tsikriktsis and Heineke, 2004) highlighted the significance of BPM approach as a critical factor in creating an output representing value for customers by focusing on management by process rather than simply addressing service quality from a functional perspective.

BPM as an increasingly used approach to managing process-oriented organizations presented by focusing on the processes that create products and/or services, rather than simply focusing on the products and services themselves (Ubaid and Dweiri, 2020; vom Brocke and Rosemann, 2010; Hantry et al., 2010). By adopting BPM, Kowalik and Tatar, (2018) stated that companies can design totally customer-focused business processes by integrating all resources needed to delight customers and eliminate inefficiencies that compromise quality of the service.

Service Process Design

According to Holmild and Evenson, (2008) and Kim and Kim, (2001), transforming customer expectations and the intended service needs to a customer service process model has become a necessity that all businesses to realize. The first step for any organization to gain competitive advantage and satisfy customer demands and requirements is the good description of service with appropriate process model (Kusak and Gurel, 2015; Reijers, 2003). The emphasis is on structured processes that must handle several cases and situations, and the process designs are frequently graphical (van der Aalst, 2004). Dijkman et al., (2011) defined process design as an organized overview of business activities with their relations and guidelines that outline how they must be implemented in the most efficient and organized manner. Modeling of business processes has always been the core of BPM initiatives as it is the way that always used to improve performance and maximize process outcomes (Becker et al., 2013).

According to Rospocher et al., (2014); Aldin and de Cesare, (2011); Aldin and de Cesare, (2009); List and Korherr, (2006); Wohed et al., (2006) and (Aguilar-Saven, 2004), the most

popular and widely used business process modeling tools are: Flow Chart Diagram, Data Flow Diagram (DFD), Workflow Technique, Role Activity Diagram (RAD), Role Interaction Diagram (RID), Gantt Chart, Integrated Definition for Function Modeling (IDEF0), Event-driven Process Chain (EPC), Unified Modeling Language (UML) and Business Process Model and Notation (BPMN). However, all of process modeling tools presented in the literature are criticized by practitioners and academics (Becker et al., 2013). The authors used the previous references to establish the following table.

Table 1: Tools and Techniques of Process Design

Tools	Definition	Purpose of use	Ease of use
Flow Chart Diagram	A formal drawing showing the control flow through a process by giving a step-by-step explanation of what happens in a particular circumstance.	To illustrate processes as a sequential flow of actions and distinct steps, and to pinpoint inefficiencies or bottlenecks where the procedure might be streamlined or enhanced.	Flexibility, Ease of use, Not take a long time to set up **Criticism:** no distinction between the primary and secondary activities, which makes it challenging to interpret the chart
DFD	A graphical representation that illustrates a system's functionality, including its fundamental functions and the movement of data between different locations.	Its purpose is to describe business processes showing how these processes relate to each other through data stores and how the processes relate to customers and external world.	Easy to understand and verify, and easy to draw and edit **Criticism:** it is only shows data flow, not materials
Workflow Technique	A graphic presentation of operations in terms of the roles provided within these operations, with an emphasis on the constituent activities and interactions between them.	Workflow technology is used to explain how work moves between computer programs or individuals in a company when numerous workers are needed to finish particular tasks in a particular order.	learning time is short, data transfer, process modify, easier to make changes **Criticism:** loss human contact, lack of motivation, feeling controlled.
RAD	A graphic presentation of operations in terms of the roles provided within these operations, with an emphasis on the constituent activities and interactions between them A diagram showing the roles of individuals, teams, etc. in an organization and how they interact with each other and in response to external events.	It is used to model business processes, displaying the roles, actions, and interactions of individuals as well as the logic and outside events that dictate the order in which those actions should be completed. RAD allows using roles, objectives, activities, interactions, and business rules to enable the schematic modeling of processes.	Easy and intuitive to read and understand by providing a detailed view of the process. **Criticism:** The process is portrayed as a sequence of steps that prevent the process from breaking down, making the overview challenging.
	Interaction diagrams are business process models that graphically show	To use RID, activities are associated with roles in an array type. Activities appear	RIDs are fairly intuitive to understand, easy to read.

RID	the interaction of different processes with each other within a system	vertically on the left axis and roles appear horizontally at top.	**Criticism:** RID tends to be messy and difficult to build, with many arrows pointing left and right
Gantt Chart	A Gantt chart is a matrix in which every task or activity that needs to be completed throughout a process is listed on the vertical axis. It is one of the most popular and useful ways to view activities shown over time.	Gantt charts related to a list of activities are on a time scale and are therefore used to graphically represent a process and control the current state of performance	It makes it easier for people involved in different parts of the process to check if all sub-processes are on schedule. **Criticism:** its use to analyze a process is limited.
IDEF0	IDEF0 is a modeling technique used to develop structured graphical representations of processes to model decisions, actions, and activities of an organization or system	It uses a common set of instructions to depict processes as flow diagrams with activities as tiles. From left to right, the process involves the following: inputs, outputs, controls, and mechanisms.	IDEF diagrams are easy to follow and read even without technical background. **Criticism:** IDEF0 tends to be interpreted as a series of activities.
EPC	EPC is a form of business process modeling that visualizes domain aspects of business operations to begin with a single activity and eventually lead to the occurrence of certain events that in turn create new activities and outcomes. Building blocks of EPC are functions, connectors, events, and edges of control flow.	An EPC diagram uses graphic symbols to show the control flow structure of a business process as a series of events and functions It can be used to characterize the possible outcomes that are more likely to occur when a particular action is taken.	One of the main strengths of EPC is its simplicity and ease of understanding by business people. **Criticism:** The starting events is not explicitly formulated in the EPC

UML	UML uses text documents and graphics to improve the analysis and design of software projects and business processes There are several types of UML diagrams, activity diagrams, and a type of UML diagram that can be used as an alternative to flowcharts.	UML is used for the purpose of visual representation of a system along with actors, roles and procedures, in order to better understand, change, maintain, or document information UML diagrams provide a more unified way to model activities workflow and features to improve readability and efficiency	UML diagrams are easy to read and flexible **Criticism:** It takes a lot of time to manage the diagram. The massive size of diagram and codes may can cause companies to lose the actual program
BPMN	One of a recent addition to the family of business process modeling languages is BPMN. It is a modern (graphical) language for the specification of business processes using simple and intuitive graphical notation that allows explicit coding of activities, control flows, data and ancillary information about the process.	BPMN used to coordinate the sequence of operations to serve the purpose of illustrating how several process components work together to represent an organization's behavior in a connected group of tasks. It is used to illustrate the steps in a business process with a detailed description of all elements, attributes, and characteristics and shows the end-to-end flow of a process.	A methodical approach to simulating several facets of an organization's activities. Enables adaptable modifications or enhancements to any function inside the expanded model without impacting the initial model. Easy to understand, use and read by business and technology users.

Statistical Machine Learning Techniques

Basically, managers need to understand that one of the deadliest threats to the success of any organization is making poor decisions (Gompers et al., 2020; Martinez-Harms et al., 2015; Evans and Lindsay, 2011). According to Fischhoff, (2020); and Balke and Gilbert, (2014), making effective managerial decisions is a vital component and the cornerstone of the planning process which requires organizations to depend on measurement and analysis of performance to provide critical data and information about key processes, outputs and results to support evaluation or reviewing the overall performance and the operational improvement. It is an inherent component of BPM according to Hammond et al., (2015); Griffin, (2013) and Eriksson and Garvare, (2005), to provide effective feedback information regarding results of a process execution which support making-decisions by choosing the best alternatives and the appropriate corrective actions can be instituted by management.

Instead of management by objectives, managers must learn the capabilities of processes and how to improve those by using data and facts to obtain meaningful information for trends and evaluation of quality improvement actions (Ioannidis, 2020; Maughan et al., 2018). Schildkamp, (2019) and Mokhtari, (2007) referred that all processes can be monitored and brought under control by gathering and using data in order to take the corrective actions where and when necessary.

According to Cox et al., (2013) and Thor et al., (2007), statistically-derived decision rules help operators to determine whether the performance of a process is stable and predictable or there is a variation in the performance that makes the process is not in a state of statistical control to minimize the deviation between the process output and specified standards. The idea is to develop a process knowledge base that aids in making immediate corrective actions whenever special causes of variation influencing the process are detected (Rai, 2008). Evans and Lindsay, (2011) and Mahanti and Evans, (2012) added that when managers give employees the authority to make good decisions, the employees must have the tools for making good decisions in order to virtually guarantee that better quality products and processes will result. By using statistical methods (SMs), Oakland, (2007) claimed that it is possible to take meager knowledge of individual items and turn it into meaningful statements which may then be used to make decisions about the process or batch of products.

The Role of Statistical Machine Learning Methods

Managers frequently make incorrect decisions during the analytical process or, maybe, when attempting to build correlations between various features, which makes it difficult for them to find solutions to specific situations (Muhammed and Yen, 2015). Machine learning is frequently successfully applied to these difficulties, enhancing system efficiency and machine design where each instance of a specific dataset is represented by the same collection of features (Kotsiantis, 2007). Machine learning refers to a vast set of mathematical and statistical methodologies that have traditionally been focused on prediction (Crown, 2015; Hastie et al., 2009). Machine learning is widely employed in a variety of fields to handle complex problems that cannot be easily solved using computer technologies (Bargarai et al., 2020; Shalev-Shwartz and Ben-David, 2014). It is one of today's fastest expanding technical

topics, lying at the interaction of computer science and statistics, as well as at the core of artificial intelligence and data science (Jordan and Mitchell, 2015). One of the primary goals of machine learning is to teach computers how to solve problems using data or prior experience (Muhammed and Yan, 2015).

Learning from data entails techniques that attempt to detect and reveal a possible hidden structure and regularity patterns associated with their generation mechanism, which in turn aids analysis and our understanding of the nature of the data, which can then be used to make future predictions (Theodoridis, 2016). A machine learns when it is able to acquire experience (through data, programs, etc.) and create new knowledge, resulting in improved performance on certain tasks over time (Izenman, 2013). In brief, the basic approach with all machine learning methods is to convert the data into learning and validation data sets to develop highly accurate classification algorithms (Crown , 2015).

As hotel industry is witnessing a radical change as a result of technology interaction such as artificial intelligence (AI) in service tasks (Al-shami et al., 2022), hotel companies have integrated robots into their business processes to capitalize on artificial intelligence in order to attract clients and solve customer concerns (Dalgic and Birdir, 2020). As a result of this revolution, the pattern of service delivery based on human interaction has shifted to digital engagement, and robots began to do activities that humans would do, such as receptionist, concierge, bellboy, and housekeeper (Al-shami et al., 2022; Dalgic and Birdir, 2020; Koo et al., 2021). Within artificial intelligence (AI), Jordan and Mitchell, (2015) referred that machine learning has emerged as the primary way for developing practical software for applications such as computer vision, audio recognition, natural language processing, robot control, and other applications.

Both the service and manufacturing sectors have the requirement to satisfy their customers (Kumar et al., 2006; Bansal and Vayer, 2000) and deliver high quality products and/or services in accordance with diverse the ever-changing requirements and needs (Goh, 2014; Mariappan et al., 2012; Deros et al., 2009). To achieve this, managers may need some forecasting tools that enable them to know the extent to which the developed service descriptions and hotel processes features fit the requirements and demands of their customers. Methods of machine learning (ML) are increasingly being employed to generate a precise forecast despite high market requirements, thus ensuring that the best possible levels of service quality (SQ) and availability are maintained (Devi and Radhika, 2018; Dobel et al., 2018; Chase, 2016). In this study, the authors will focus their attention on the methods which are being used for prediction. This study will contribute to new researchers for getting up-to-date knowledge about ML approaches in hotel industry. The following table 2 illustrates the most popular statistical machine learning and techniques.

Table 2: Statistical Machine Learning Methods and Techniques

Ref.	Techniques	Pros and Cons
		Statistical Methods
Xanthopoulos et al., (2013) Tharwat et al., (2017) Sharma and Paliwal, (2015) Ye, (2007) Zhu et al., (2022) Wen et al., (2018)	**LDA**	Linear Discriminant Analysis (**LDA**) is a popular preprocessing technique for dimensionality reduction challenges in machine learning and pattern classification applications. LDA is used to model differences in groups, in other words, to separate two or more groups. It is used to project features in a higher dimensional space into a lower dimensional space. Find the variance between the groups using the following formula: $$S_{ii} = \sum x_i^2 - \frac{(\sum xi)^2}{n}$$ $$S_{ij} = \sum x_i x_j - \frac{\sum x_i \sum x_i}{n}$$ One of the benefits of LDA is that the problem solution can be obtained by solving a generalized eigenvalue system, allowing for quick and huge data sample processing. The objective function of classical LDA needs the non-singularity of one of the scatter matrices, which is an inherent constraint. LDA may fail when the assumption is violated, especially when a class comprises several clusters (or subclasses).
Peng et al., (2002) Tripepi et al., (2008) Steyerberg et al., (2001) Ranganathan et al., (2017) Sperandei, (2014) Anderson et al., (2003) Cokluk, (2010)	**LR**	Logistic regression (**LR**) is a supervised machine learning technique that performs binary classification tasks by estimating the likelihood of an outcome, occurrence, or observation. LR analysis is a statistical technique to evaluate the relationship between an independent variable (either continuous or not) and a dichotomic dependent variable (or dummy variable) (that is, a variable with only two potential values: 0=outcome absent and 1=outcome present). The following equation represents logistic regression: $$y = \frac{e^{(b_0 + b_1 X)}}{1 + e^{(b_0 + b_1 X)}}$$ Where x= input value, y= predicted output, b0= bias or intercept term and b1= coefficient for input (x) LR is well suited for expressing and testing hypotheses concerning correlations between one or more categorical or continuous predictor variables and a categorical outcome variable. In the presence of more than one explanatory variable, logistic regression is used to calculate the odds ratio where the impact of each variable on the odds ratio of the observed event of interest is the result.

		Logistic regression estimates the odds of a result by statistically modeling or replicating that event and characterizing it with a regression equation. . The key advantage is that by assessing the connection of all variables together, confounding effects are avoided.
	Machine Learning Techniques	
Walczak,(2019) Wang and Wang, (2003) Yang and Wang, (2020) Dongare et al., (2012) Basheer and Hajmeer, (2000) Grossi and Buscema, (2007) Yang, (2009)	**ANN**	Artificial Neural Network (**ANN**) is a model that emulates a biological neural network by utilizing a subset of principles from a biological neural system. As ANNs incorporate comprehensive information and a significant amount of domain knowledge, once the input variables existing in the neural network's input vector have been picked, training data for these variables with known output values must be acquired. Each connection is associated with a numeric number called *weight.* The output, *hi,* of neuron i in the hidden layer is: $$h_i = \sigma\left(\sum_{j=1}^{N} V_{ij}x_j + T_i^{hid}\right),$$ where σ is called activation (or transfer) function, *N* the number of input neurons, *Vij* the weights, *x j* inputs to the input neurons, and *Tihid* the threshold terms of the hidden neurons. Because of the nonparametric nature of neural networks, models can be created without prior knowledge of the distribution of the data population or probable interaction effects between variables, which is required by commonly used parametric statistical approaches.
Song and Ying, (2015) Kotsiantis, (2013) Kingsford and Salzberg (2008) Priyam et al., (2013) Gupta et al., (2017)	**DT**	Decision trees are logical models that incorporate a series of simple tests; each test compares a numeric attribute to a threshold value or a nominal attribute to a range of alternative values. A decision tree is a flowchart-like tree structure in which internal nodes are represented by rectangles and leaf nodes are represented by ovals. It is the most often used method since it is simpler to construct and understand when compared to other classification algorithms. A decision tree classifies data objects by asking a sequence of questions regarding the items' attributes. Each question is a node, and each internal node points to one child node for each conceivable answer to its query. Decision trees are adaptable enough to deal with items that have a combination of real-valued and category features, as well as items that lack some qualities. Unfortunately, modest changes in the input data can occasionally result in huge changes in the tree's structure.

3. Research Methodology

After presenting the theoretical literature of the problem under study, the theory will be applied to a relevant real-life case. To answer our research questions, authors conducted 15 case studies throughout October and December 2022, which varied between international chain hotels (ICHs), local chain hotels (LCHs) and independent hotels, considering that the research was limited to only five-star hotels. The purpose was to include hotels that had sufficient resources in terms of people, facilities, finance, time and technology to be effective for effective implementation of management programs and systems such as BPM approach and statistical applications, and whose managers can provide relevant information about BPM projects and quality activities in their organizations. In addition, low-rated hotels not seen as typical utilizers of the process-oriented approach (BPM) and the value of a process-oriented services in such settings is not as prominent.

Sample Description

The research sample comprised all five-star hotels located within the Greater Cairo area, which number about twenty four (**24**) hotels based on the latest hotel census conducted by Ministry of Tourism and Egyptian Hotel Association (2022). After excluding hotels belonging to the same chain (**4**) to avoid getting repeated information and save time, the number of hotels becomes twenty-two (**20**).

A total of twenty (**20**) hotels were intended to be invited for the data collection process in the study; fifteen (**15**) hotels agreed to participate and only two hotels (**2**) rejected the invitation. The researchers stopped at **17** hotels when no new knowledge or insights were gained, as advised by the authors Cooper and Schindler, (2011) to keep sampling only when breadth and depth of the knowledge of the issue under study are expanding. In qualitative research, Lingard et al., (2008) and Coenen et al., (2012) refer that the sample size is sufficient when additional interviews do not lead to the identification of new results and differentiated concepts, an end point called data saturation. Therefore, the study participants represent **75%** of research population.

Data Collection Method

In order to collect in-depth opinions from the participating managers, a questionnaire in the form of a semi-structured interview technique was employed. As a result, interviews become much more tightly controlled in order to give the researcher more control; they basically turn into spoken questionnaires with written responses (Barrett and Twycross, 2018). This approach has the advantage of direct communication between interviewers and interviewees which can ensure that the latter has a good understanding of the interview questions (Lai and Choi, 2015) and, where necessary, the interviewer can provide clarification for any queries that interviewees may have (Harrell and Bradley, 2009).

The theoretical literature nearly set the agenda for questions that must be answered by the selected sample in order to be able to appropriately analyze the data obtained and to keep a red line within this thesis. The researchers considered using a five-point Likert scale in the study to evaluate the use statistical methods in the selected hotels since it would increase both

the response rate and the quality of the answers. Likert scale used to measure respondents' attitudes to particular questions or statements related to the use of statistical methods (SMs) of quality process control and improvement within their hotels according to several assessment criteria including: relevance, importance, use, understanding, application, management, training and benefits. The suitability and validity of questions were tested on a sample of manufacturing firms and service organizations by the authors (Bandara et al., 2007; Grigg and Walls, 2007; Herbert et al., 2003; MaQuater et al., 1996). The five-scale points were developed as follows:

1 = no value
2 = low value (that is, little used, not understood, little or poor training, etc.)
3 = some value (that is, basic understanding, some benefits, etc.)
4 = high value (good understanding, some benefits, reasonable training, etc.)
5 = very high value (that is, complete understanding, excellent benefits, effective training, etc.)

Data Analysis

Data analysis, which is the process of organizing obtained data in a meaningful way, is necessary for qualitative research (Liamputtong, 2009). Interpretive thematic analysis, often known as theme analysis, is a popular form of data analysis in qualitative research (Markovic, 2006; Walters, 2016). The most popular application of theme analysis in tourism research has been its interpretation of written materials, including transcripts of interviews (Walters, 2016). In the thematic analysis, researcher looks for themes within the collected data and codes excerpts into those themes which enable a structured approach to data interpretation (Cassell and Bishor, 2019). In addition, closed-ended answers (Likert Scale) were analyzed by using the statistical package for social sciences (SPSS) version 21, which computed frequencies, percentages, means and standard deviation between variables.

The researchers made a connection between the empirical data and the theoretical literature on each factor. In theoretical framework, researchers established a clear description of the criteria regarding each factor and each phase, and used the criteria as the main tool for data analysis. During this process, researchers have resorted to the secondary data several times when researchers find the obtained data are not enough to examine the case. At the end of analysis, all of questions of the current study have been successfully answered, research objectives have been achieved, and some suggestions will be promoted to help hotel managers better implement BPM initiatives in the future and provide the foundation for further research in this scientific topic that has not been sufficiently studied yet.

4. Results and Discussion

The study starts with investigating the level of coverage of BPM core areas in hotels in order to interpret the responses obtained from hotels managers regarding their current use of statistical methods (SMs) and tools in the daily operation management and provide the foundation for future research in this scientific topic. Therefore, this section divided into three main parts: (i) the level of BPM core areas coverage in hotels; (ii) the use of process design tools and techniques in hotels and (ii) the use of statistical machine learning methods. These topics will be discussed with the major issues of each subject.

The study was conducted in five-star hotels operating in Greater Cairo, being one of the biggest hotels with operation in Egypt, which managed by major international chain companies and implement the latest management programs and practices. Within the selected hotels, the study focused on the operation processes of hotels once is a very important hub for providing services to hotel guests and gaining business objectives. The selected hotels are process-oriented services (100%). Respondents were mainly aged between 35 and 45 (86.7%) and had a university education (100%). Most interviewed personnel had worked at their respective hotels for 10–20 years (80%). The proportions of female respondents were 6.7%.

Hotel Managers' Perception of BPM Approach

The term BPM is a broad term, and different people may give totally different definitions which create a lot of confusion and challenge facing enterprises when managing their processes and improve operation activities (Adesola and Baines, 2005; Thomas et al., 2009; Bandara et al., 2007). This part is to investigate what process orientation means from hotel managers` perspectives and how they interpret the BPM message in their hotels. To achieve this, questions such as: *'How would you define the term BPM'? 'In your own opinion what role(s) do BPM currently play in your hotel?'* and *'What's the related issue of BPM efforts in hotels?'* are developed. The findings obtained through this part grouped into two categories: (**i**) managers` perception of BPM approach and (**ii**) the role of BPM in managing service activities in hotels.

The main focus of BPM is mostly into BPs and its capabilities to provide the advantages that are value to customers through managing all of value-generating activities employed within companies (vom Brocke and Mendling, 2018; Ohtonen and Lainema, 2011; Biazzo and Brnardi, 2003). The current study revealed that hotels focus on managing its critical service processes considering it the main contributor to improve service performance and achieve hotel objectives instead of the traditional way of viewing hotel as a set of functions and only observing the capability of completing any task. However, all interviewed managers (100% of respondents) failed to give a certain and comprehensive definition to BPM due to the lack of knowledge about the philosophy of BPM as adopted by the owner company and its core areas. The first main observation is that there is no an agreement from all hotel managers on what BPM actually means and what it can provide.

Majority of hotel managers (73.4%) referred to BPM in a simple way as *"the way of managing hotel processes"* and this based on the way that a hotel gets its work done and how the day-to-day activities are accomplished. From their perspectives, BPM is related mainly to *"how to manage hotel activities in a certain manner to obtain more valuable results"* concentrating only on one aspect of business rule management and execution constraints ignoring other BPM aspects, in particular on the technological aspect and supporting methods and techniques that support process enactment. Few managers (26.6% of respondents) see that *"BPM is more about organizing business activities by dividing it into simpler procedures to make service process more flexible and facilitate management functions"* which can be considered the closest definition to the concept of BPM reported in literature, although it focuses on only one aspect of BPM, which is the operational aspect.

The various viewpoints and lack of a general agreement over BPM frequently lead to misunderstandings and conflict regarding the real expectations and advantages of BPM in hotels. *This may make managers confused about what must be done and what objectives need to be achieved.*

Using Service Design Techniques in Hotel Industry

The owner company define the operation processes of hotels and its critical-to-quality characteristics in the form of a set of standard operating procedures (SOPs) and specified execution steps for all hotel service processes such as check in, check out, calls handling, reservation process, complain handing,…etc. and hotel managers are only required to understand these pre-defined specific standards and implement it as designed and planned by the owner company without change or modification. All hotel managers (100% of respondents) confirmed that and they have no idea about the methods used to plan hotel processes or the sequential stages followed to perform this task and prepare a complete written texts of business activities and SOPs of operation processes. Therefore, the tools and techniques of service design and hotel processes planning not exist within Egyptian hotels and not common among hotel managers not as there is a lack of knowledge, education or experience of managers, but rather the management policy and instructions of the owning company which the selected hotels in the sample belong.

The following table (3) shows the answers obtained from the interviewed hotel managers regarding the use of service design tools and techniques inside their hotels, all of which were negative according to Likert scale and reflect a real problem in the management process in hotels. The overall mean of the data collected analysis was (1), with a standard deviation of (0). This result indicated that there is a common agreement among hotel managers not to use any of the service design tools or even just be aware of them, which is remarkable because the policy of persuading management of the owning companies has a noticeable impact on hotel operating processes. Where all hotel managers, whether in ICHs or LCHs, agree that the service design process is not one of their tasks or a common management function within hotels, and therefore the tools related to it are not familiar with.

Table 3: Using of Service Design Tools and Techniques in Hotels

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
FCD	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
DFD	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
WORKFLOW	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
RAD	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
RID	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
GANTT	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
IDEFO	15	.00	1.00	1.00	1.0000	.00000	.00000	.000

EPC	15	..00	1.00	1.00	1.0000	.00000	.00000	.000
UMLL	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
BPMN	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
Valid N (listwise)	15							

This means that one of the three managerial functions of quality management in hotels, which is "Service Planning", is not assigned to managers in hotels based on the policy of the owner company. It should be noted that the most of responses obtained from managers in independent hotels in this regard were unstable and uncertain in many times. Therefore, it excluded because it not serves the purpose of the study and may be a source of confusion.

Interviews with 15 hotel managers with different positions, ages, experiences and education, showed that there is a wide range of reasons to why the philosophy of BPM is performed in hotels, the most common of which is identifying the critical characteristics of hotel operation processes that can provide valuable results as expected by customers, transformation of hotel processes into defined standard operating procedures, identification of strength and weaknesses in existing hotel operating processes, distribution of roles and responsibilities, and facilitation of organizational performance transformations.
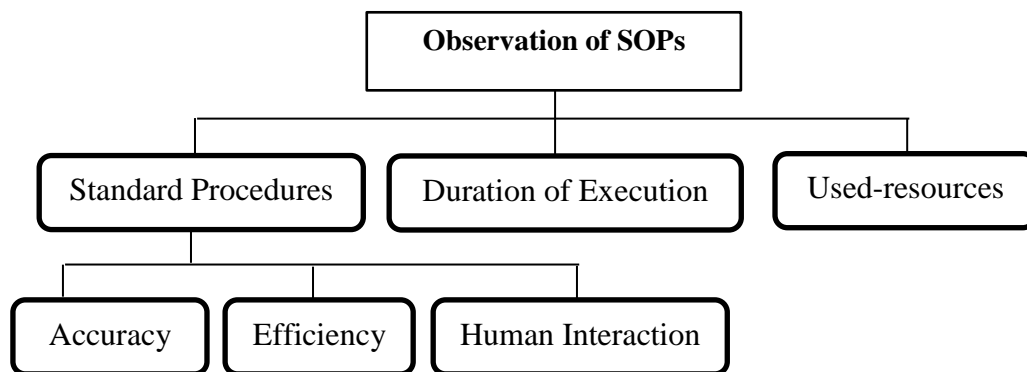
Statistical Machine Learning Methods and Techniques

According to the actual use of statistical machine learning methods and techniques in Egyptian hotels, all hotel managers observed that there is no a need to use such statistical methods through all phases of managing hotel operation processes. The phase of SOPs execution is a critical phase of any BPM lifecycle in hotels as it help companies to achieve their key objectives of business and customers gain better products and/or services. This stage is to put the hotel`s processes into practice and perform operational activities with the purpose of providing valuable results to customers and attaining the expected outcomes for business. In this stage, hotel managers mentioned that process specifications are performed and SOPs transformed into an actual workflow of actions done within specific time until the final product and/or service is reached or producing a given result meet the identified needs and requirements of their customers.
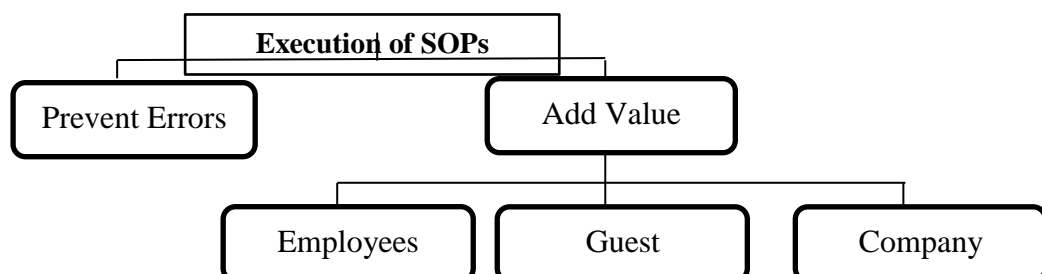
The stage of execution followed by observation (check, monitor, measure and verify) with the aim of monitoring process performance and checking the quality outputs. Through this phase, managers continuously observe the outcome of an executable service processes and collect required data to verify the proper implementation of SOPs and execution constraints,

evaluate the actual outcomes and detect the missing points of the standard operating procedures in order to ensure their compliance with conformance objectives and business goals.

All managers in ICHs and LCHs agreed on that service processes (SPs) are evaluated based on specific criteria including the accurate and rigor execution of service process procedures without missing points or procedures, efficiency and adaptability in implementing SOPs of hotel activities, quality of interaction between the service-provider and service-receiver, faultlessness, duration of execution, used-resources and risks involved on which they can take the appropriate corrective actions according to the origin of detected mistakes and unexpected errors.

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                    ┌─────────────────────────┐
                    │   Observation of SOPs   │
                    └─────────────────────────┘
          ┌───────────────────┬────────────────────┐
┌──────────────────┐ ┌──────────────────────┐ ┌──────────────────┐
│Standard Procedures│ │ Duration of Execution │ │  Used-resources  │
└──────────────────┘ └──────────────────────┘ └──────────────────┘
     ┌──────────┬──────────────┐
┌──────────┐ ┌──────────┐ ┌──────────────────┐
│ Accuracy │ │Efficiency│ │ Human Interaction │
└──────────┘ └──────────┘ └──────────────────┘
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From hotel managers` perspective, there are many indicators of hotel performance stability that can be used to evaluate performance efficiency and detect service defects in hotel operation such as the rate of customers' complaints, customers` feedback and their comments on hotel websites, customer survey, customer complaints, customer reviews, direct observation, employees' survey, employees` notes and monthly/ weakly Evaluation.. Therefore, managers in the selected hotels indicated that they hold a regular weekly or monthly meeting to discuss the received complaints and active problems in the work environment and identify the most probable causes of those problems considering the different factors may cause the different operation problems such as lack of SOPs understanding, poor quality of materials, malfunction of information system, lack of employees training and knowledge, used-equipment, work environment conditions…etc. As a result, the actual use of statistical methods and machine learning techniques is also not common among hotel managers as they depend on some traditional tools and indicators to evaluate and improve operation activities and the whole hotel performance.

Table 4: Using Statistical Machine Learning Methods in Hotels

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
LDA	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
LR	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
ANN	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
DT	15	.00	1.00	1.00	1.0000	.00000	.00000	.000
Valid N (listwise)	15							

The previous table (4) shows the managers' responses regarding the assessment criteria of statistical machine learning methods and techniques within their hotels using the indicator numbers, all of which were limited to choice number (1), which indicated that there was no value of all stated statistical methods (SMs) and machine learning techniques which was mentioned previously, within their hotels. The overall mean of the data collected analysis was (1), with a standard deviation of (0). The answers obtained means that statistical methods (SMs) are not a suitable technique for monitoring the dynamics of hotel performance and evaluating business progress from hotel managers` perspective, and therefore there is no actual application for these methods and techniques within their hotels. Based on this, there is a state of complete lack of understanding of these techniques among hotel managers, which is justified by the lack of an urgent need to apply it as long as the senior management or the owner companies did not request it or set statistical methods (SMs) as a basic requirement for the administrative process within hotels.

Statistical Analysis in Hotels

In the same context, hotel managers indicated that they often deal with statistical data or percentage tables without actually using statistical methods and techniques through mystery shopping companies. Mystery shopping is a technique involving looking at hotel business from an outside view point which measure the efficiency of hotel key processes performance to evaluate its compliance with regulation or standards operating procedures (SOPs) and business objectives. The majority of respondents (80% of cases or 12 hotels) use the mystery shopping to evaluate hotel performance, examine the quality of provided services and determine the weak points in the work environment by contracting with a third-part company provides the mystery shopping services. Mystery shopper is generally not known by hotel managers being evaluated for once or twice a year and his stay at a hotel does not exceed 3 nights.

As soon as his departure, the mystery shopper submits the collected data to the mystery shopping company, which reviews and analyzes information and completes quantitative or qualitative statistical analysis reports on the collected data for the client hotel. Then, the company provides the client hotel with a detailed report or feedback about its experience including a comprehensive evaluation for all services and standards, and detailed information about the strength and weak points in a hotel. Therefore, by using the mystery shopper`s report, the management can evaluate hotel performance, quality of service and the organization itself depending on the results of statistically-analyzed reports.

Customer survey is also one of the most common tools or methods used by managers in Egyptian hotels in order to evaluate hotel performance and control quality of the provided service. Few hotels (20% of cases or 3 hotels) do this survey itself, but the majority of respondents (80 % of cases or 12 hotels) depend on external parties such as the owner or management companies, and in some cases, they contract with a third-party company to do this task.

The previous mentioned companies are responsible for sending a survey to the guest the day after his departure directly, including 48 questions about 3P (people, processes, and place). At the end of the survey, there are some additional questions if the guest will recommend the hotel to his or/her friends, if there is intention to return again, and finally his personal suggestions to improve his or/her satisfaction. Then, the company reviews and analyzes all answers of the customers to prepare a detailed report with a complete statistical analysis to help managers determine the quality of the provided service and evaluate their hotel performance depending on the results of the statistically-analyzed report of customers` responses.

Another important results is that there is no way can be considered reliable and valid for studying the two scientific research subjects: (**i**) the tools and techniques used by the head office executives of ICHs and/or LCHs to design hotel operation processes and prepare its standard operating procedures (SOPs) based on the pre-defined service features and quality characteristics, and (**ii**) the related issues of defining service processes in the hotel industry and the issues related to transforming hotel business functions into a set of operation processes with specific SOPs.

The study revealed that BPM initiatives in hotel industry are riddled with many problems and need some reformulation in specific aspects, such as: (**i**) planning of hotel operation activities and designing the critical-to-quality characteristics of service processes in the hotel industry must begin and end with the hotel operation managers to follow up on all measures taken to implement service processes and execute hotel operating activities in its proper sense; (**ii**) hotel managers should be trained in order to improve their knowledge of service design tools and techniques in terms of how to use it and the various considerations that need to be taken into account when using these techniques for service design; (**iii**) the use of statistical methods and tools must be strengthened and enhanced within hotels and make a major requirement for the administrative process at all levels of management to make managers rely on statistical reports and graphical analysis before making any managerial decision.

5. Conclusion

The quality of products and/or services across all businesses is a direct reflection of its ability to improve its operation processes through implementing BPM approach supported by statistical methods (SMs) and service design tools and techniques. The study revealed a fatal error in the management of service processes within hotels as a result of incorrect application of BPM initiatives, which resulted in the absence of the use of appropriate statistical methods and tools to effectively monitor quality outcomes of service design and evaluate process performance. Therefore, statistical methods must be included within the service quality management tools in the hotel industry for more effective management procedures and better performance results. Additionally, this means that no method can be considered valid and reliable for identifying the methods and tools used to design hotel operation processes; and (ii) the problems associated with defining service processes in the hotel industry and turning hotel business functions into a set of SOPs.

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تقييم تطبيقات أساليب التعلم الآلي الإحصائي و تقنيات تصميم الخدمة في صناعة الفنادق

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معلومات المقالة	الملخص

تعد إدارة العمليات التجارية نظامًا أساسيًا لأي منظمة تأمل في العثور على إجابات إبداعية لقضايا العمل الصعبة وتوفير فرص جديدة للتقدم وإيجاد الميزة التنافسية. إن استخدام تقنيات تصميم الخدمة والأساليب الإحصائية كأدوات داعمة لمبادرات إدارة العمليات التجارية في صناعة الفنادق لم يتم تناولها في الأدبيات الإدارية من قبل ولم يتم تحديد علاقاتها المتبادلة مع أهداف إدارة الجودة، مما يعني وجود صعوبات عند وضع مفهوم عملية الخدمة في حيز التنفيذ الفعلي. تهدف الدراسة إلى دمج الأساليب الإحصائية في مبادرات إدارة العمليات التجارية المُطبقة في الفنادق وتقديم رؤى حول التقنيات الإحصائية ذات الصلة لتحسين عملية صنع القرار وكيفية ارتباط هذه الأسباب بممارسات إدارة الجودة في الفنادق. من خلال دراسة نوعية وكمية شاملة تضمنت مقابلات متعمقة شبه منظمة مع مديري فنادق الخمس نجوم في مصر، حاول المؤلفون التحقيق في هذا الموضوع الذي لم تتم دراسته بشكل كافٍ. وخلصت الدراسة إلى أن مستوى تغطية المجالات الأساسية لإدارة أعمال الأعمال منخفض في صناعة الفنادق وأن هناك حاجة لدعم نهج إدارة العمليات التجارية بالأدوات والتقنيات المناسبة، وخاصة الأساليب الإحصائية الضرورية لإدارة جودة الخدمة وأداء عمليات التشغيل بشكل أفضل.

الكلمات المفتاحية

إدارة العمليات التجارية؛ أساليب التعلم الآلي؛ الإحصائية؛ اتخاذ القرار؛ تصميم الخدمة؛ صناعة الفنادق.