

Transforming Hotel Supply Chain Using Intelligent Decision Support System: Prospects and Challenges

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ABSTRACT

Modern technological innovations are driving the trends to digitalize the hotel supply chains. The most famous and used technologies are artificial intelligence, robotics, blockchain, and advanced predictive analytics. These technologies provide the tools that will inevitably redesign and transform many aspects of the hotel supply chains. Thus, this study aims to investigate the opportunities and chart the path to adopt the Intelligent Decision Support System (IDSS) in hotel supply chain management. IDSS is a computerized information system that facilitates the decision-making process by creating alternatives, which can then be evaluated using a set of predetermined patterns to make reliable and fact-based decisions. To that end, this study engaged in 12 Delphi survey with hotel managers and key industry experts in Egypt and received additional inputs from 70 structured surveys conducted amongst four and five-star hotels located in Cairo, Giza, Alexandria, Sharm El-Sheikh, and Hurghada which allow a deeper insight into the prospective scenarios of how IDSS could be applied in hotel supply chain management. The results unveiled that the hotel supply chains in Egypt are moving towards digital transformation, albeit with slow steps. Also, the results revealed that data quality, analytical decision-making capabilities, and transformational impacts appear to be critical factors that influence the adoption of IDSS. A key finding of this study is that Egyptian hotels cannot reap the integration advantage of IDSS technology without additional engagement with supply chain partners.

Introduction

The hotel supply chain is inherently complex, and decision-makers are constantly facing more impactful disruptions and risks such as demand uncertainty, high supply risk, fast-flowing information, the amount of day-to-day decisions and the number of parties involved in these decisions, and the extreme volatility in the market environments (Min, 2010). As the COVID-19 pandemic of 2020 hit the globe in late 2019, another risk has emerged: the need for flexible planning to address any supply-side agitations due to border closures and disruption of global logistics networks

(Hobbs, 2020). For the global hotel industry, this has meant a notable decline in occupancy rates, leading to mass closings (González-Torres *et al.*, 2020). These challenges have placed the hotel supply chains under severe pressure, resulting in a marked decline in revenue and liquidity problems for all hotels (De Rosa *et al.*, 2020).

In supply chain management, the risk is inevitably related to uncertainty because the most prevalent reason for contingency is the ambiguity of the potential consequences arising from flawed data or unexpected situations (Ho *et al.*, 2015). Risk prediction reduces vulnerability while achieving higher robustness and flexibility. The decision-making process for managing supply chain operations is a multi-faceted process that indicates the complexity of the supply chain itself, including aggregating and analyzing data from all parts of the supply chain. (Baryannis *et al.*, 2019). It is no longer appropriate to make supply chain management decisions based solely on experience and assumptions. Decisions should be fact-based and derived from accurate data about processes, outputs, and expected key results. The decision-making process must ensure that decisions are informatively sound, reflect different perspectives, and promote integration between partners (Power, 2019).

To that end, two of the established technologies that have been applied by several big hotel supply chains to optimize supply chain strategic decisions and to alleviate risks are artificial intelligence (AI) and robot-based applications (Primawati, 2018). Recently, there have been arguments on the adoption of such technologies to digitalize hotel supply chains after its widespread recognition in manufacturing supply chain management (Kamble and Gunasekaran, 2020). AI-based technologies are characterized by enough intelligence to effectively replace rational human activities while enhancing the agility and efficiency of business processes (Power, 2019). AI and robotics have many benefits for the supply chain processes. For example, AI can emphasize collaboration in all supply chain activities, and this, in turn, allows for the full integration of the entire supply chain operations. Additionally, AI has added a unique dimension that has radically transformed the nature of hotel supply chain principles and practices (Nam *et al.*, 2020). The impetus for this dramatic transformation, which is described by some as a "*tsunami-like transformation*", emerges from the fact that AI is a powerful approach facilitating the synthesis and synchronization of all supply chain data and processes (Teniwut and Hasyim, 2020).

Intelligent decision support systems (IDSS) emerged as a new technology that allows data synthesis and analytic abilities to assist stakeholders in making appropriate decisions (Min, 2010). Simply, IDSS is an interactive smart system or subsystem which uses appropriate data, models, reports, knowledge, and information technologies to enhance the ability of decision-makers to solve complex problems and make optimal decisions. Particularly, helping supply chain decision-makers transact with intricacies and risks (Power *et al.*, 2019). Importantly, the systems enable electronic data collection from all relevant stakeholders along the supply chain to derive important perspicacity and models from the bulk data collections (Astill *et al.*, 2019).

IDSS is revolutionizing the supply chain management, enabling innovative techniques of designing and transforming supply chain operations to enhance firms' performance by improving existing practices, reduce wastes, and provide trustworthy inventory management (Hazen *et al.*, 2016), resulting, in turn, in improving businesses' competitive edge. Considering the sheer volume of purchases that hotels handle, the massive volume of heterogeneous data, the complexity of operating business activities, the need to make proper and timely decisions, and the constant changes in consumer behavior and expectations (Cetin *et al.*, 2016), IDSS will be a highlight feature in effective hotel supply chain management and thus will become more strategic and pervasive (Kimes, 2017). According to Ransbotham *et al.* (2017), businesses embrace IDSS to sustain a competitive advantage and penetrate new markets, signifying an aggregate strategic purpose for IDSS. The same authors added that apart from the strategic goals that result from adopting IDSS, it is well-recognized that IDSS offers many other benefits such as reducing cost, increasing operational effectiveness, and maximizing profits. A recent survey conducted by *Accenture* of global supply chain leaders found that 3 out of 4 agree that directing more investments into the IDSS is the fastest path to achieve the organization's goals, especially financial ones, as 72% have witnessed a growth in revenues or an increase in profitability as a result of leveraging intelligent technologies (Accenture, 2018).

Buhalis *et al.* (2019) predicted that during the next 75 years, this technology will reshape and transform the hotel industry in general. However, the readiness of hotel supply chains to embrace such technological transformation seems equivocal (Nam *et al.*, 2020). Several leading hotel supply chains around the world such as Hilton Worldwide, Marriott International, Ritz Carlton, Four Seasons Hotels, AccorHotels, Inter-Continental Hotel Group, and Starwood Hotel do leverage various AI and robot-based technologies by fully implementing the latest technological systems (Haaser *et al.*, 2018; Francis, 2019). On the other hand, many hotels still rely on traditional supply chain arrangements, although there are opportunities to improve decision-making using technology. This obvious contradiction is the motivation for this study. Currently, while the topic of AI applications in the hotel industry is getting more attention, research in this field is still insufficient and needs more considerations. (Tussyadiah, 2020), particularly in the Egyptian context. Thus, this study is aimed toward addressing the following questions:

1. Do hotels in Egypt have technological decision-making capabilities and have they been used to influence decisions related to supply chain management?
2. Do these hotels have any predictive tools in place for prospective situations that could influence supply chain management?
3. What are the prospects to adopt IDSS to transform the hotel supply chains in Egypt?
4. What are the benefits and challenges that could result from this radical transformation?

To conceive a deeper understanding of its potential and to bridge the gap in the literature about IDSS adoption in supply chain management, the primary objectives of this study are, thus, fourfold.

1. Recognize the current reliance on AI in managing hotel supply chain processes.
2. Determine the maturity of the hotels' intelligence systems (i.e. data quality, data integrity, and analytical capabilities) that can influence the supply chain decision-making process.
3. Identify and gather insights into the expected transformational impacts of IDSS adoption on the hotel supply chain decision-making process.
4. Propose an "IDSS adoption Framework" to support hotels in prioritizing their IDSS investments.

The significance of the current study arises from several aspects. First, it adds to a rising stream of exploratory research aimed at exploring the readiness of the hotel sector to incorporate digitalization transmutation in supply chain operations (Lam and Law, 2019). Second, the study examines the latest practices and applications of AI in managing the hotel supply chain. Finally, this study makes a real-life contribution by drawing on the verdicts and feedback of experts and hotel managers to develop an 'IDSS adoption framework' to support hotels in prioritizing IDSS investments.

Literature review

Fundamentals of Intelligent Decision Support System (IDSS)

An intelligent decision support system (IDSS) refers to a system or subsystem that simulates human intelligence to perform tasks and support decision-makers by providing reliable information using logic and probability (Power, 2008). Electronic interactive tools were integrated into decision-making systems in the 1960s to handle structured intricacies (Min, 2010). During the 1970s, practitioners were instigated to apply smart technologies to resolve unstructured problems at various managerial levels. In this era, DSS converged on promoting specific decision-making. In the 1980s, consideration progressively stirred to create systems capable of supporting consolidated and organizational decisions to address intricated problems and intensify DSS efficiency at the organizational levels (Chen *et al.*, 2012). In the early 2000s, an integrated IDSS, involving IT, expert systems, business AI, and communication systems, were introduced in a blended context to meet competitive challenges (Power, 2012).

Over the past two decades, a series of broadly adopted technologies like machine learning, autonomous vehicles, context-aware computing, predictive analytics, reinforcement learning, and deep learning have allowed computers to “*think*” and make decisions by implementing a conceptual structure for processing data and making decisions based on such data (Gupta *et al.*, 2018). With the tremendous technological advances in the fields of mobile and cloud computing and information processing algorithms, the applications of IDSS have increased dramatically (Dash *et al.*, 2019). IDSS is formed of interactive and integrated subsystems. IDSS ranges in complexity, from calculators, simulation, and analytical models to artificial intelligence models that rely on analyzing complex data found in complicated information management systems (Power *et al.*, 2019).

In a schematic sense, IDSS is composed of four key subsystems: user interface, database, pattern, and IDSS network. A knowledge-based subsystem is another optional plugin that can be included (Turban *et al.*, 2005). Power (2012) offered a radical IDSS structure comprising the major databases (or knowledge bases), modules, communications, and elements of the user interface. In general, the overarching framework of IDSS, as shown in Figure (1), consists of a database/document base, knowledge-based component, quantitative models, communication, and dialogues (Kasie *et al.*, 2017).

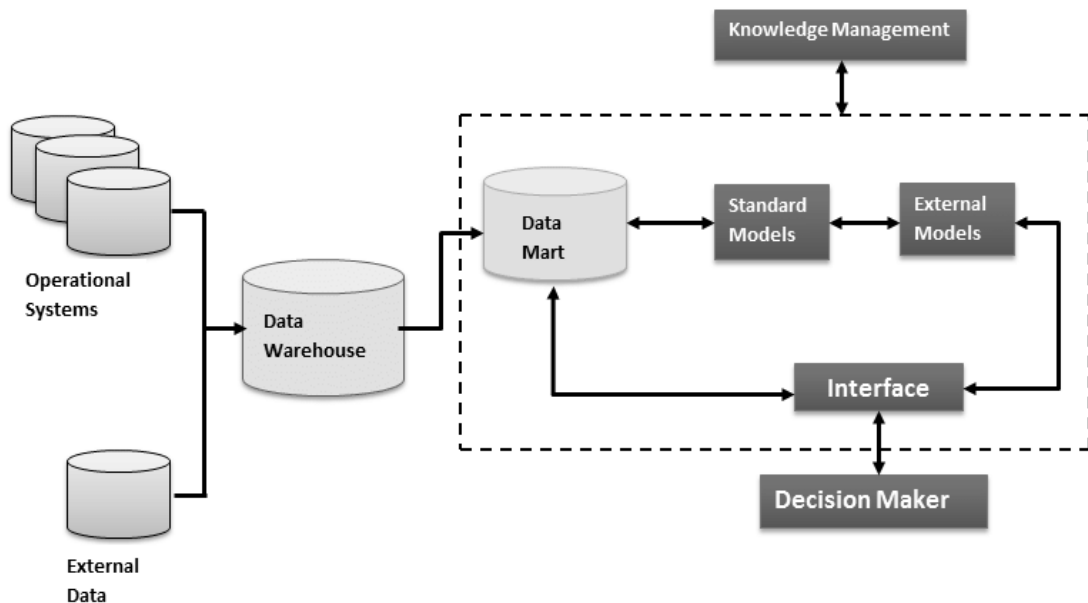


Fig.1. Methodological structure of the IDSS

Source: Adapted from Kasie *et al.* (2017)

In a typical IDSS, the database contains the required data, which can be integrated with the corporate data repository and managed by database management software (Turban *et al.*, 2005). To increase the effectiveness of IDSS, the document database can work autonomously or within the common database component. Recently, document-based DSS is being developed to overcome data-based DSS limitations. The findings of a current study confirmed that only 20 % of the data flowing in the systems is structured data; the remaining 80% of data is concealed in unstructured records (Feki *et al.*, 2013).

On the other hand, the knowledge component provides the intelligent capabilities that characterize IDSS and are linked to the knowledge repository (Turban *et al.*, 2005). This component has the expertise needed to solve problems in a specific area (Power, 2012). Further, IDSS must be adapted to the changing needs of decision-makers through integration with expert systems to serve as rational advisors to help decision-makers to understand and articulate their problems in a systematic way (Kasie *et al.*, 2017). To provide interpreted representation capabilities for IDSS, quantitative models such as AI, data mining, online analytical tools, and simulation are integrated as interactive components or subsystems of IDSS. Depending on the complexity of

the problems, these analytical tools assume the task of building partially or fully customized analytical or simulation models that can generate several alternatives to the decision-maker based on several hypothetical scenarios of the business environment (Ransbotham *et al.*, 2017).

As for the communications subsystem, it is a volitional subsystem because it can be integrated into a multi-user IDSS and suspended in a single user IDSS. It indicates how devices are arranged; how programs are allocated; how system ingredients are combined and simulated using the interface, webserver, client-server, and mainframe computer (Power, 2012). Finally, one of the primary tools of any IDSS is the user interface, which allows synergy between the system and the user to interact and give instructions. It is sometimes called a query, reporting, and front-end developing tool. It consists of menu-driven, charts, lists, icons, representations, graphs, diagrams, and web browsers (Kasie *et al.*, 2017).

IDSS Technology in Supply Chain Management

As smart devices are applied in supply chains, the amount of data being generated is rapidly growing beyond the capabilities of systems to process them. The implementation of dispersed systems such as the Internet of Things (IoT) and blockchain bolster this trend (Hofmann and Rüsçh, 2017). Recently, supply chain management has been recognized among the promising IDSS application areas (White, 2017). This enables organizations to make critical decisions related to forecasts of demand, which allows improving their sources in terms of procurement and order processing, thus reducing costs related to transportation, warehousing, and supply chain management. Besides, IDSS enables organizations to accurately identify changes in supply and demand even with uncertain situations. For decades IDSS has been adopted to resolve manufacturing supply chain hurdles, including demand forecasting, interspersed planning, sourcing collaboration, uncertainty analysis, and inventory management (Yao, 2018). While some organizations have implemented IDSS in specific areas of supply chain activities, others have integrated IDSS into all supply chain activities to make better decisions regarding managing supply chain challenges and uncertainties (DeAngelis, 2015). IDSS tools have also provided companies with the ability to collect data demonstrating partner transparency by sharing best practices for food safety standards, green practices, and business ethics (Seman *et al.*, 2019).

Simulation-based DSS is a prominent application of IDSS, which currently is gaining much attention in the literature (Petering, 2011). A simulation pattern of recurring supply chain processes is applied to support real-world decision-making. Various patterns are available for modeling and simulation. However, one of the most likely models is agent-based modeling and simulation. This model is ideal for dynamic and spatially dispersed supply chains, such as hotel supply chains (Hilletoft and Lättilä, 2012). Empirical results of several studies have shown that this type of DSS can help firms in different tracks (Nilsson and Darley, 2006; Frayret *et al.*, 2007; Hilletoft *et al.*, 2010; Hilletoft and Lättilä, 2012). For example, this model provides a systematic approach to evaluate available alternatives (Hilletoft and Lättilä, 2012). Moreover, the simulation model enables the decision-maker to create recurring parameters,

manage alternatives, and evaluate outcomes (such as key performance indicators and deviations). The data used can be obtained from corporate databases, records, discussions, and reports in the existing business system. This designates that the agent-based modeling and simulation system integrates data from varied roots in a synergistic model that presents an effective guide for human decision-making (Hilletoft and Lättilä, 2012).

A Multiple-agent system has also been applied as an inventory management simulation tool to decrease costs (Chan and Chan 2006), improve integration and collaboration between supply chain entities about uncertain supply and demand (Kwon *et al.*, 2007). In 2011, Giannakis and Lewis progressed ahead simulation to investigate the knowledge capabilities of multi-agent systems related to supply chain risk management. In this study, all potential supply chain risks were analyzed by controlling KPIs to identify deviations that were subsequently evaluated to determine their root causes. Through active case-based learning, past decisions were analyzed to identify similarities with the current scenario, and then the ideal decision was made, its impacts analyzed and quantified. Finally, all data has been preserved for future comparisons with similar situations and scenarios. In a recent study conducted by Blos *et al.* (2018), a comprehensive framework for controlling supply chain disruption was proposed. The proposed framework integrated a multiple-agent system with the production flow systems to discover ambiguities and promptly suggest mitigation plans.

In recent years, IDSS has been applied to support decision-making in purchasing and inventory management and to forecast fluctuations in the external environment (Kimbrough *et al.*, 2002). For example, Liao and Hsu (2004) proposed an intelligent decision support system for supply chain integration by supporting bid selection and negotiation and assist the decision making. In 2005, Hadikusumo *et al.* proposed an intelligent supply chain management system that can support buyers in cataloging, negotiations, searching for materials, and creating smart contracts. Mangina and Vlachos (2005) created an IDSS to decipher the complexities, enhance the flexibility of the supply chain, eases access to data, and enhance productivity.

Practically, the Hyatt Regency hotels in the USA were pioneers in embracing artificial intelligence. The hotels are now capable to predict the future demand for food supplies and generate highly accurate electronic staffing plans (Hospitalitynet, 2006). Lee *et al.* (2009) created an IDSS that can automate orders and deal with suppliers based on distinct models. Liu *et al.* (2011) introduced a new methodology based on IDSS to manage contingencies and control exceptional circumstances. The results of the study conducted by Alsetoohy and Ayoun (2018) indicated that hotel purchasing practices in the United States are carried out by agent-based modeling and simulation. Table (1) summarizes the current IDSS adoption for each of the supply chain's functional areas.

Table 1

Summary of current IDSS for each of the supply chain's functional areas

	Integrate	Observe	Predict	Adapt	Optimize
Demand planning	Sharing predictions	Consumption data	Demand prediction	Factors affecting demand	Determine the value-maximizing output
Inventory management	Stock tendency	View level of Inventory	Prophecy expected stock levels	Factors driving to stock out/low	minimum/maximum inventory levels
Supply planning	Mismatches in supply and rescheduling	Compare estimates	Mismatches in supply/demand	Experiences with suppliers	Optimal aggregates of products
Warehouse management	Combine all warehouses	Inspect stock levels	Divine projected storage needs	Learn from market trends	Choose the optimal storage capacity
Distribution management	Integrate data in dynamic route	View data on product flow	Optimal routing and delays	Learn from experiences	Improve network performance
Quality assurance	Integrate with supplier database	Monitor conditions	Predict equipment failure	Learn from experiences	Optimal warranty management policy
Risk management	Predict risk events	Monitor risk events	Predict risk events	Adjust the supply chain	Electronic analysis of risk

Source: Baryannis et al. (2019)

To successfully implement IDSS in hotel supply chain management, firms need to overcome several challenges (Davenport and Ronanki, 2018). The key barrier to IDSS adoption in the hotel sector is the lack of interaction, communication, and engagement between supply chain stakeholders (Dhagarra *et al.*, 2019). Key stakeholders in hotel supply chains involve governments, suppliers, business entities, AI solution providers, and customers/end users (Pólvara *et al.*, 2020). Thus, interoperability is a critical aspect of IDSS adoption. Interoperability is defined as the ability of stakeholders to harmoniously work together (Astill *et al.*, 2019).

Another barrier to IDSS adoption is attributed to its technical complexity and the extended training time. Valore *et al.* (2019) concluded that IDSS may not be absorbed swiftly. In addition, IDSS is still costly and bears some challenges because it is relatively new, and hotels often lack the expertise to adopt it. Moreover, there is ambiguity about the various impacts that IDSS can cause, which could lead to adverse consequences (Nam *et al.*, 2020). Internet connectivity is another technical obstacle that hotels may encounter for IDSS technology to function. There is imperative to connect IDSS systems to the Internet using a centralized network or through the cloud systems (Klonoff, 2017). Besides, internet connectivity is also a critical issue in

developing countries that may have no or limited broadband internet access technology (Saltzman, 2016). In addition, data protection is another concern for implementing IDSS. IDSS devices could be vulnerable to hacking, which leads to either illegal data collection or tampering with the device's function. Data quality (accuracy, consistency, timeliness, relevance, and added value) and governance are also critical to IDSS adoption (Wiseman *et al.*, 2018).

Methodology

The measurement model and data collection methods

The present study focuses on exploring the opportunities to adopt IDSS in hotel supply chain management. Based on a broad range of research literature review, the study identified and grouped manifold dimensions affecting the IDSS adoption into three categories: current intelligence system maturity, use of data to manage supply chain operations, and the expected transformational impacts of IDSS (Popovič *et al.*, 2012; Blos *et al.*, 2018; Baryannis *et al.*, 2019; Dhagarra *et al.*, 2019; Kopyto *et al.*, 2020). Accordingly, the proposed model for the study is shown in Figure (2).

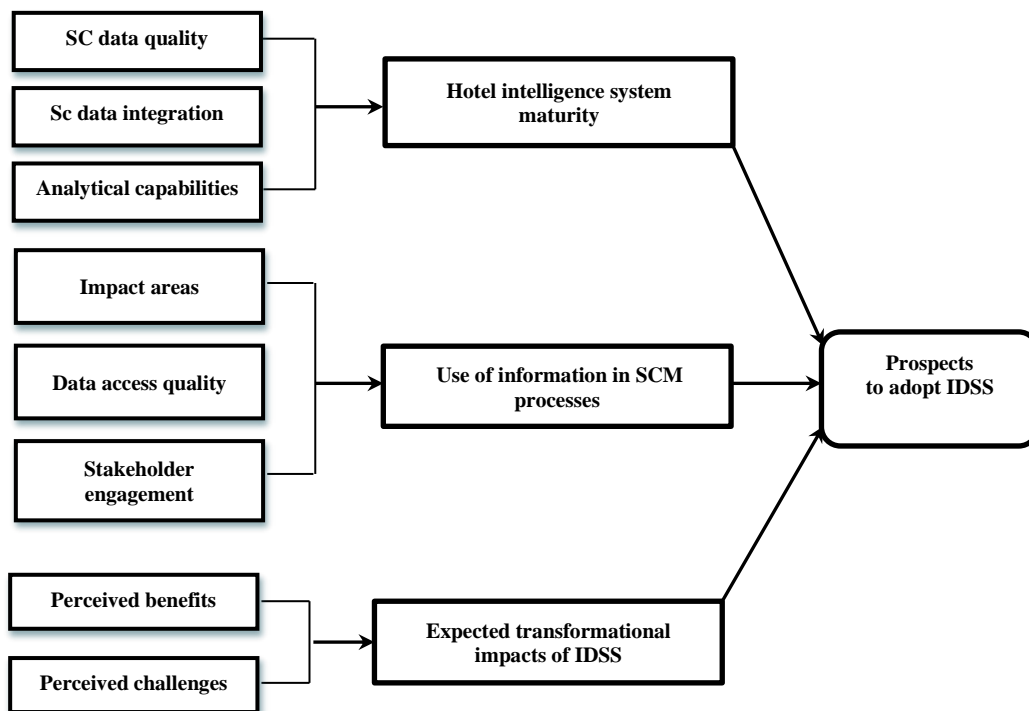


Fig.2.The proposed model for the study

The initial findings from the study were obtained from a *Delphi* survey with hotel managers and key industry experts in logistics and supply chain management. In addition, some academics researching the topic of the hotel supply chain have been consulted. The purpose of the *Delphi* survey was to generate and validate a clear portfolio of weighted criteria that could be used to determine the opportunities and perceive the path to IDSS applications in hotel supply chain management. This approach was chosen because experts' judgments are a well-recognized methodology for future scenario studies and the examination of new technologies and their

adoption in the industry (Lohmer and Lasch, 2020). A *Delphi* survey was conducted in April 2020 with 12 experts (i.e. operations managers, consultants, and academics). At the end of the *Delphi* survey, the initial version of the cross-sectional survey-based approach was reviewed and verified. Based on the feedback received from the *Delphi* survey, the wording of some items has been slightly altered to match the context of this study. These comments were considered in the final survey conducted amongst four and five-star hotels in Egypt. The questionnaire surveyed the intelligence system maturity, the use of information in supply chain management processes, and the expected transformational impacts on the hotel industry. Dichotomous scales and categorical scales were adopted to structure the questionnaire. The participants were asked to rate the extent of their agreement or disagreement with the statements presented on the five-dimensional Likert scale. The questionnaire consisted of four main sections. The first section was designed to identify the profile of the investigated hotels, including the form of ownership, duration of marketing presence, annual gross profit, and the status of IT adoption. The second section of the survey investigated hotels' intelligence systems maturity and whether they are being used to influence decisions related to supply chain operations. The survey conceptualized systems maturity as a multidimensional construct that includes the quality and integrity of supply chain data and hotel analytics capabilities. This information is crucial because hotels need to determine their technological capabilities before investing in IDSS practices. Hotels that are immature in their capabilities cannot implement many IDSS practices. Three questions were addressed in the third section to evaluate the use of information in supply chain management processes. Finally, respondents were asked about their perception of the expected transformational impacts of IDSS.

Population and sampling procedures

Given that artificial intelligence is mainly embraced in luxury and high-end hotels (Rodríguez-Algeciras and Talon-Ballester, 2017), the population structure for the current study included all five and four-star hotels operated in Egypt during 2019/2020. Surveying these categories would present accurate trends of adopting AI in the hotel supply chain management because these hotels are invariably considered the leaders in applying modern technological approaches such as IDSS. Moreover, these categories have the privilege of incorporated organizational and technological practices, personal and fiscal resources, and standard operating procedures. Therefore, the target population included all four and five-star hotels located in five significant tourist regions in Egypt; namely, Cairo, Giza, Alexandria, Sharm El-Sheikh, and Hurghada. These areas were selected because they house a variety of high-end five and four-star hotels. According to the statistics of the Egyptian Hotel Association (EHA) for the year 2020, these regions include (96) five-star hotels and (141) four-star hotels. An email invitation was sent to these hotels with a cover letter contained the scope of the study, a description of the important terms, and a comment ensuring the confidentiality of responses. Finally, a total of 32 hotels, (23%) of all four-star hotels and 38 hotels, (40%) of all five-star hotels, agreed to participate in the survey. Mainly, supply chain managers were targeted. In the absence of such a position, purchasing managers, operations managers, and IT managers were targeted as final respondents. Between July 15 and December 27, 2020, online surveys were

conducted. This approach was appropriate due to the exceptional circumstances that the hotel industry going through due to the outbreak of the Coronavirus which led to the imposition of strict preventive measures in most hotels.

Data processing and analysis

The study model was tested using the PLS regression approach for several reasons. First, it is suitable for emerging subjects. Second, it is appropriate for small samples, not exceeding 250 observations (Benzidia *et al.*, 2021). The PLS model requires three main constituents: delimiting the quality of relationships between measures, estimating the reliability and validity of the measures, and evaluating the overall model. As shown in Table (2), to determine the degree of internal consistency, the reliability of the scales was tested using coefficient alpha (*Cronbach's alphas α*). Further, the constructs/measures were evaluated using confirmatory factor analysis. Cronbach's alphas indicated a high degree of internal consistency for the entire attributes (ranged from 0.711 to 0.903) which is considered appropriate (Aichouni *et al.*, 2014). In addition, the results reported in Table (2) indicate that the reliability scores are above the accepted cut-off value of 0.70 (Hair *et al.*, 2018).

Table 2
Research measurement items

Construct/measure	Mean	SD	Factor loadings	AVE	α
Supply chain data quality (DQUA)					
The hotel considers SC data as an asset	4.68	1.25	0.78	0.830	0.802
The hotel draws on large data sets (data warehouses or cloud platforms)	3.01	1.42	0.84		
The hotel uses IT-enabled processes for fact-driven decision-making	3.87	1.08	0.86		
The SC data is accurate, consistent, and trustworthy	3.06	1.51	0.75		
The SC data is up-to-date and not obsolete	3.64	1.23	0.71		
The SC data is free of distortion, bias, or error	3.36	1.35	0.77		
Supply chain data integration (DINT)					
The hotel combines and integrates information from many data sources	3.12	1.28	0.79	0.609	0.903
Data in the sources are reciprocally consonant	2.25	0.99	0.72		
Supply chain analytics capabilities (ACAP)					
Paper-based records	3.62	1.11	0.76	0.756	0.799
Ad-hoc reporting and analysis	3.87	1.54	0.71		
Electronic data processing (ELDP)	2.62	1.43	0.77		
Analytical applications (e.g. trend analysis and what-if scenarios)	1.87	1.09	0.83		
Data mining	2.25	0.99	0.72		
Dashboards, metrics, key performance indicators, alerts	1.47	1.33	0.85		

continued

Impact areas in supply chain management (IARE)					
Strategy development	3.12	1.46	0.87	0.778	0.732
Inventory/stock control	4.14	1.22	0.76		
Long-range sales forecasting	4.03	1.26	0.85		
Identifies problems within existing processes and functions	4.03	0.87	0.75		
Demand volatility	4.89	1.15	0.76		
Risk management	4.12	1.15	0.76		
Stakeholders engagement in AI initiatives (SENG)					
Potential of hotel suppliers to participate in IDSS initiatives	2.25	0.89	0.78	0.764	0.715
Potential of hotel network operators to participate in IDSS initiatives	2.03	1.04	0.76		
Integration of all activities with supply partners	1.90	1.09	0.87		
Data access quality (DACC)					
The provision of data corresponds to users' specific needs	4.08	1.45	0.87	0.765	0.786
The information is processed and delivered rapidly without delay	3.62	1.43	0.78		
There is a governance plan of privacy/confidentiality	3.00	1.40	0.76		
Identify vulnerabilities and opportunities within existing SC practices	3.63	1.33	0.80		
Staff development (skills, cultural competence, and training)	4.04	1.12	0.76		
Perception on IDSS implementation benefits (PBEN)					
Better/more informed decision-making	3.92	1.25	0.75	0.698	0.725
Better management of supply chain risks	4.35	1.33	0.74		
Improvement in responding to changing environments	3.00	1.32	0.76		
improving integration and data sharing with suppliers	3.07	1.65	0.76		
Better control and management of demand	3.65	0.97	0.71		
Perception on IDSS implementation hindrances (PHIN)					
Lack of financial support from top management	3.01	1.21	0.77	0.875	0.711
IDSS solution is technologically complex (fear factor)	3.34	1.19	0.70		
It is difficult for staff to digest these technologies	2.76	1.23	0.87		
IDSS solution is time-consuming	3.45	1.07	0.74		
Data security and privacy concerns	4.06	0.98	0.87		

Results and discussion

Profile of the surveyed hotels

A summary of the profile of the investigated hotels is presented in Table (3). The respondents were asked to rate their hotels based on their form of ownership. It is worth noting that about (68.4%) of the respondents from five-star hotels and (56.3%) of the respondents from four-star hotels determined that they are part of international chains or groups. Also, respondents were asked to indicate the duration of operation of their properties. More than a quarter of the four-star hotel sample (34.4%) has been operating for less than ten years. In contrast, only (13.1%) of the five-star hotel chains have been operating for less than ten years. Therefore, it can be inferred that the hotels that participated in this study have both the experience and the well-known brand name.

Table (3)

Profile of the respondent hotels

<i>Attribute</i>	Five-star hotel chains (<i>n</i> = 38)		Four-star hotel chains (<i>n</i> = 32)	
	Freq.	%	Freq.	%
Form of property ownership				
Part of international chain/group	26	68.4	18	56.3
Independently owned and operated	08	21.1	05	15.7
privately owned / leased operation	04	10.5	9	28.0
Duration of market presence				
< 10 Years	05	13.1	11	34.4
From 10-20 Years	22	58.0	12	37.5
> 20 Years	11	28.9	09	28.1
Annual profits (EGP Million)				
Less than 100 million	00	0.0	01	3.1
From 100 to less than 300 million	09	23.7	22	68.8
More than 300 million	29	76.3	09	28.1
The number of hotel employees				
< 300 employees	00	0.0	02	6.2
From 300 to 600 employees	04	10.5	12	37.5
> 600 employees	34	89.5	18	56.3
e-SCM implementation status				
Ready	00	0.0	00	0.0
Future	02	5.3	4	12.5
Partial	09	23.7	12	37.5
Full	27	71.0	16	50.0

For the current study, the total number of employees was used as an indicator of the hotel size instead of the number of rooms. The study detected a noticeable variance between hotels in such points. The largest percentage of the investigated five-star hotels (89.5%) was from large-size. The workforce in 34 five-star hotels reached more than 600 employees, while 9 of them (24%) fall in the range of medium-size

that include 300 to 600 employees. There are no hotels with less than 300 employees. These results are not surprising when considering that five-star hotels in Egypt tend to be medium to large. Moreover, most five-star hotels (76.3%) generate more than 300 million EGP as annual revenues. On the other hand, the workforce of 18 four-star hotels (56.3%) employs more than 300 employees, while only 12 of them (37.5%) fall in the range of 300 to 600 employees. Moreover, 22 four-star hotels (69%) generate between 100 and 300 million EGP as annual gross revenues, while a minority of these hotels (3.1%) generate less than 100 million EGP as annual revenues. As shown in Table (3), most hotels rely on electronic supply chain management (e-SCM) to support daily operations in supply chain management. This result reiterates the fact that digitization is increasingly adopted by various hotels in Egypt. Chi-square (χ^2) test was used to compare the sampled hotel annual revenue, hotel size (number of employees), and proportion of IT implementation. Results of the Chi-Square tests showed that there are no significant differences between these control variables (significant at $p > 0.05$).

The assessment of the structural model

Likewise, the results indicated that all factor loadings are significant ($P < 0.001$) and above 0.70 (Hair *et al.*, 2018), and that the average variance extracted (AVE) outperformed the preferred cutoff value of 0.50 (Yu *et al.*, 2021). Hence, these findings confirm the converging validity of the proposed model. Ultimately, all variables were examined based on the Fornell-Larcker model to assess the discriminative validity of the constructs and measures. According to this model, the square root of the AVE for all variables should be higher than the intrinsic correlations of this variable and greater than all other variables as well. The results (Table 4) indicated a distinctive presence of the variables because the bold values exceeded the correlations between the variable and all other variables. Thus, the construction dimensions are confirmed for the set and satisfied the expected concepts as theorized. Hence, the results showed the study's measures were appropriate for this study.

Table 4

Inter-construct correlations and the square root of AVE

Construct	DQUA	DINT	ACAP	IARE	SENG	DACC	PBEN	PHIN
DQUA	0.961							
DINT	0.624	0.879						
ACAP	0.670	0.643	0.855					
IARE	0.564	0.543	0.655	0.674				
SENG	0.436	0.413	0.654	0.593	0.879			
DACC	0.743	0.524	0.657	0.542	0.592	0.874		
PBEN	0.700	0.572	0.744	0.691	0.634	0.754	0.876	
PHIN	0.654	0.564	0.578	0.646	0.732	0.678	0.623	0.981

Note: DQUA= data quality; DINT= Data integration; ACAP= Analytics capabilities; IARE= Impact areas; SENG= Stakeholders engagement; DACC= Data access quality; PBEN= Perceived benefits; PHIN= Perceived hindrances.

Following the validation of the measurement model, the consideration is assigned to the structural model analysis. Using the path coefficients (β) and the squared R (R^2), the structural model provides important indications regarding the path significance of assumed relationships. The results of the structural model analysis are shown in Figure (4). As seen in Figure (4), the R^2 value (0.68) is moderate in the PLS path model indicating that there were no multicollinearity problems found in the model.

Surprisingly, only six out of the eight hypothesized measures were supported. It is confirmed that the quality and integrity of the data will lead to the maturity of the hotel intelligence system and thus greater prospects for the adoption of IDSS technologies. The data analysis supported that data access quality is an important factor for the hotel industry in the adoption of IDSS. Similarly, the notion that stakeholders' engagement is significant in promoting IDSS acceptance in Egyptian hotels is also supported. Moreover, the data analysis supported the impact of the perceived benefits and challenges on IDSS acceptance and thus adoption. The data did not confirm the remaining factors. Table (5) displays a summary of the results. The collective variables explain 51% of the variation in the dependent construct. This implies that the suggested study conceptualization has enough and appropriate impending power in explaining the IDSS acceptance of the investigated hotels. It should be noted that the characteristics of the surveyed hotels in terms of the total number of employees and IT implementation status were determined to have a significant relationship with the dependent variable. Their impacts were slightly high to confirm their relevance in this study. Additional analysis of the findings of this study is conferred in the next section.

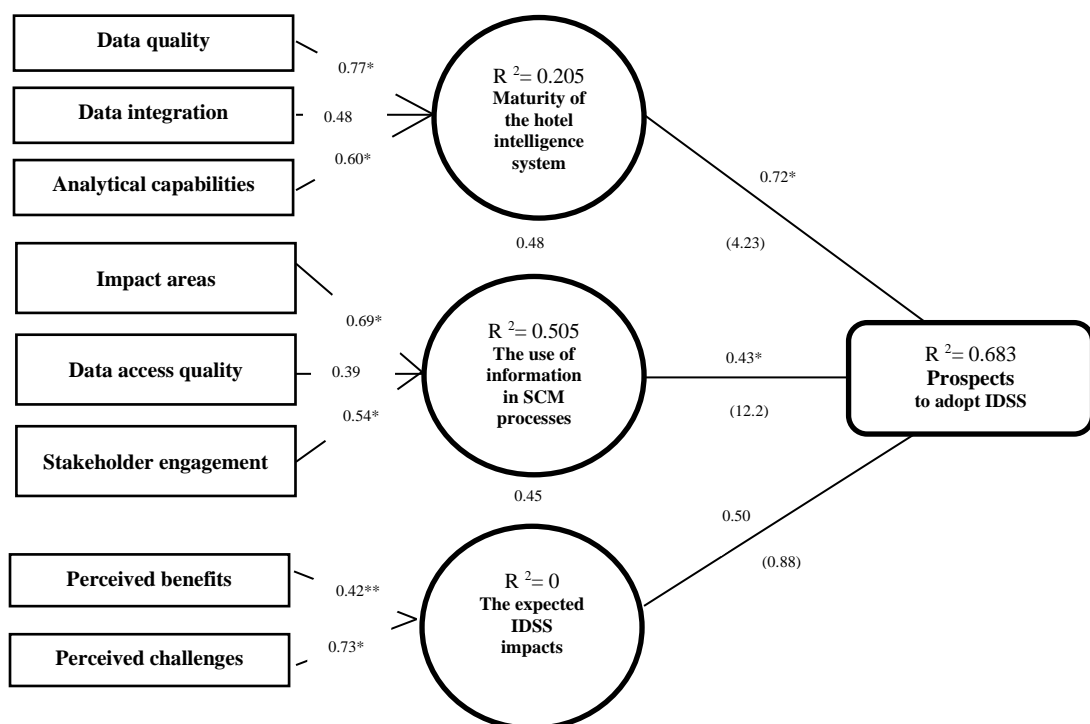


Fig.4. The PLS structural model analysis results

Table 5
Summary of the results

Attribute	The model			Result
	with control	without controls	with all factors	
F1: Data quality		0.77*	0.476*	Supported
F2: Data integration		0.48	0.419	Not Supported
F3: Analytical capabilities		0.60*	0.207*	Supported
F4: Impact areas		0.69*	0.90*	Supported
F5: Data access quality		0.39	0.307	Not Supported
F6: Stakeholders engagement		0.54*	0.205*	Supported
F7: Perceived benefits		0.42**	0.590	Supported
F8: Perceived challenges		0.73*	0.385*	Supported
Adoption of IDSS			0.022	R² = 0.683
Form of ownership	0.054		0.086	
Duration of operation	-.033		-0.017	
No. of employees available	0.265*	0.023	0.016	
Annual profits	0.034		0.045	
IT implementation status	0.263**		0.029	

Note: * = significant at $p < 0.001$; ** = significant at $p < 0.005$

Discussion and Implications

Reliance on recent technological innovations along the supply chain has become an inevitable necessity to enhance supply chain performance. Among the various technological innovations, the Intelligent Decision Support System (IDSS), which can process an enormous amount of data in a short time, play a central role. Along with the advancement of the information age, IDSS has attracted real interest from researchers and practitioners, after realizing the great value that an IDSS implementation can bring to commercial organizations. This study provides an initial examination to explore the opportunities and chart the path to adopt the (IDSS) in hotel supply chain management. Further, the study combined factors such as intelligence systems maturity, use of information in supply chain management processes, and perception of the expected transformational impacts which may, to some extent, positively or negatively moderate the adoption of IDSS. The measurement model was verified with good reliability and validity for the examined constructs/measures. The model rendered a comprehensive exposition ($R^2 = 0.683$) of the willingness of hotels in Egypt to adopt the IDSS. Most of the results are harmonious with those of contemporary studies that examined IDSS adoption in the supply chain management context in other developing countries, i.e. Malaysia and India (Kamble *et al.*, 2019; Wong *et al.*, 2020). The key results of the present study have strategic implications that provide insights for designing and implementing IDSS for hotel supply chain processes.

The results indicated that the size of the hotel significantly affects the prospects for adopting emerging technologies such as IDSS. As the hotel size increases its operational resources, the ability to control uncertainties and paybacks increases in

turn. Hence, substantial hotels are more amenable to embrace emerging technologies to be a step distant from their rivals. A recent study confirmed that firm size is a focal determinant of the enactment of innovative technologies in supply chains (Mendling *et al.*, 2018). Also, the results indicated that the technological readiness of hotels positively affects the prospects for adopting IDSS. Technological readiness refers to physical resources, qualified and trained human resources, and knowledge and culture (Grant, 2009). Technological readiness is essential to accommodate new systems, satisfying the prerequisite of hardware, systems support, and physical facilities (Oliveira and Martins, 2010; Yang *et al.*, 2015). In IDSS systems, data is stored in the firm's IT devices to maintain data query at any time (Francisco and Swanson, 2018). Individual competencies and the technological intellectual basis are of specific importance in assuming IDSS systems (Wang *et al.*, 2017).

The survey data linked supply chain data quality and analytical capabilities as two dimensions of hotels' intelligence systems maturity. System maturity, in its simplest form, refers to the state of being entirely developed, and this study conceptualized system maturity as a multidimensional construct that includes three dimensions: data quality, data integrity, and analytics capabilities. Specifically, it seems that both dimensions are significant, yet the quality of supply chain data is considerably more significant for achieving more eminent IDSS maturity. Decision support systems literature presents a similar tendency. Studies suggested that data quality is a starting point for implementing IDSS (Seddon *et al.*, 2010; Popovič *et al.*, 2012). The literature suggested that IDSS implementation projects should focus on issues related to data quality in supply chains data-intensive activities such as future demand planning and procurement processes (Mena *et al.*, 2016; Mishra and Singh, 2016; Wang *et al.*, 2017; Arunachalam *et al.*, 2018). Data quality affects many supply chain operational aspects such as demand planning, order tracking, capacity, and planning data. The efficiency and effectiveness of a hotel supply chain can be augmented by utilizing reliable and up-to-date data in the decision-making and through the consistent stream of data across the whole supply chain. Hotels with high-quality data are deemed more promising to adopt IDSS. It is perhaps unsurprising that this study confirms that data quality and hotel analytical capabilities significantly influence the maturity of hotel intelligence systems, which in turn impact the prospects to adopt IDSS across the supply chain.

The reliance of a large sector of hotels in Egypt on electronic supply chain management (e-SCM) has led to the existence of common systems with suppliers and the exchange of a great amount of electronic data over the Internet, which has resulted in strengthening the culture of communication, coordination and information cooperation across the hotel borders (Lin, 2014). The adoption of these systems inevitably leads to the generation of a vast amount of data within the supply chain network. In addition, practices such as collaborative planning and forecasting generate additional data that needs to be stored and leveraged (Chae and Olson, 2013). Hence, the hotel supply chain's marketplace is determined by its capabilities to generate and analyze high-quality data. A supply chain with data-generating capabilities gains a competitive advantage through its ability to accurately predict its

business environment. The ability to generate data refers to the imperative for hotels to have the tools, technologies, and practices that facilitate the collection of large, diverse, and renewable amounts of data. Therefore, hotels must address two important issues when creating their IDSS architecture: 1) integrate vast amounts of data from diverse heterogeneous sources and 2) implement sound analytical capabilities (such as Ad-hoc reporting, trend analysis, what-if scenarios, data mining, electronic data processing (ELDP), broadcasting, and data mining to analyze supply chain data.

However, the findings suggest that data integration does not impact the prospects for adopting IDSS. These unexpected results reflect that hotels in Egypt give less emphasis to the level of collected data integration. Hotels need to realize that unless the data exchanged is highly integrated with supply chain partners, they cannot expect a high return from their IDSS initiatives. Shared decisions and dispensing risks and interests will not improve the performance of the supply chain if the data exchanged is of poor quality or not integral. Therefore, this study makes an important acquaintance by unveiling that hotels in Egypt focus primarily on the physical aspect (equipment and technological infrastructure) while snubbing the integrity of the data flow. Data exchanges between hotels and supply chain partners are temporal and targeted towards a specific object, as they do not perceive the value of compatible data definition/components, unbiased data entry, and data exchange as well. In addition, the finding brings consideration to the effective influence of data analytics capabilities and their pivotal role in the success of IDSS adoption. Consequently, to perceive the ample likely benefits from IDSS adoption, hotels need to prioritize investment to improve the quality of shared data between supply chain partners on the one hand and to enhance their analytical capabilities on the other hand. For hotels attempting to achieve higher levels of IDSS adoption, it is a priority to solve data integration predicaments with the partners of the supply chain (for example, issues of data quality and security, data management, technological infrastructure, technical skills for data integration, data transformation and gathering) which can prevent achieving the desired outcomes from the EDS adoption.

Currently, a notable proportion of hotels in Egypt still rely on manual sources of data for the decision-making process. Prominent examples include paper-based reports with suppliers and receipt of raw materials by visible inspection only. Automated data acquisition technologies are preferred as several technologies can be integrated into supply chain management systems such as sensors. Besides increasing transparency, incorporation of these sensors into supply chain infrastructure is beneficial to hotels, as they automatically produce data to make important management decisions (Astill *et al.*, 2019). Certain technologies are available to ensure data accuracy, namely, data warehouses and cloud platforms that enable data retrieval at any time and from anywhere (Panarello *et al.*, 2018; Košťál *et al.*, 2019).

The findings of the present study endorsed the results of prior studies that investigated the effect of IDSS on the various parts of the supply chain. In general, according to the results of the study, it is found that IDSS in the supply chain will mostly use to control demand volatility. This could be because hotels are subject to various demand management issues such as obsolescence of goods and wastage, especially for

perishable items. IDSS can enable the supply chain to operate simultaneously, and thus ensuring low inventory costs and quick response times (Zhong *et al.*, 2015; Raman *et al.*, 2018). The second problem area that will also use a lot of IDSS methods in the supply chain was inventory and stock control. The IDSS for inventory management and control and their pertinence have been examined by (Achabal, 2000; Behesthi, 2010; Arnott and Pervan, 2016). The results demonstrated the value of a decision support model in lessening the cost of inventory and the cost of products sold. The third problem area that will use IDSS methods in the supply chain was risk management. For risk management, a decision support system would be beneficial. Appropriating an aggregate of data retrieval, patterns, and analytical techniques helps assess and improve assess proper alternatives. A properly designed DSS would help decision-makers to make decisions and recognize and interpret risks and predicaments.

This study gives additional evidence for the multi-faceted nature of the hotel supply chain. The results indicated that stakeholder engagement in the hotel supply chain, which has four integrated levels; manufacturers of original products; top-notch suppliers; sub-layer suppliers; network infrastructure suppliers is a significant factor for IDSS adoption prospects. The key attributes of supply chain synthesis are data sharing, collaboration, and adaptability (Cheng *et al.*, 2010). Active data sharing and collaboration can enhance supply chain visibility and avoid information lags and falsifications, which can lead to tremendous inconsistencies and inefficiencies (Cheung *et al.*, 2012). Hotels should note that engagement is a multi-dimensional concept, which is the consequence of interacting actions such as data partition, mutual decisions, and incentive alignment. Therefore, to boost engagement, hotels need to recognize the three dimensions to create operational outcomes. Although the data exchange by itself does not necessarily lead to integration between the supply chain partners, it will lead to sharing of high-quality information (i.e. more relevant, trustworthy, and appropriate information) between the partners. Such a practice among supply chain partners would help to evolve the relationship to the point that more important and even restricted data would not be withheld from the chain partners.

This study revealed that the perceived benefits are a significant variable that impacts the prospects to adopt IDSS in the hotel sector. These results are compatible with those of Lin (2014) and Martins *et al.* (2016) about e-SCM adoption. This applies well to the IDSS application as it offers several advantages (Iansiti *et al.*, 2017; Kim and Laskowski 2017; Ramanathan *et al.*, 2017). In particular, the results of the current study confirmed the general advantages denoted in several studies regarding the influence of timely data in improving the management of supply chain risks (Reaidy *et al.*, 2014; Kumar *et al.*, 2016). The second top-ranked benefit was the improvement in the decision-making processes (mean=3.92), a crucial element to achieve efficiency improvements in the supply chain. Reliable planning and management of demand took the third position by reducing wastefulness of inventory data (mean=3.65), which supports the empirical evidence of previous studies (Reaidy *et al.*, 2015; Thiesse and Buckel, 2015). The fourth inherent benefit identified was enhanced

synthesis and data sharing with suppliers (mean = 3.07). Besides improving internal decision-making (Mann, 2015), IDSS adoption gives hotels a competitive advantage by redesigning all processes to improve the supply chain's overall performance. The improvement in responding to the changing environment was identified as the fifth benefit (mean=3.00), which will allow hotels to reduce costs (Li and Li, 2017).

Although IDSS assuredly introduces many advantages for hotel supply chain management if appropriately applied, its enactment necessitates challenges from many perspectives, especially the in-house aspect of the organization. The hotel supply chain is often characterized as being risk-disinclined, conventional, and rebellious to the embracement of subversive adjustments. Consequently, the novelty of IDSS inflicts the greatest hurdle towards its market adoption (Wyers, 2019). This dilemma must be overcome as the inability of hotels to implement IDSS could have future impacts on their operational efficiency and competitiveness. Hotel managers also need to understand the value that IDSS application can add to supply chain processes and plan accordingly. In turn, a critical task for policymakers and hotel managers is to provide specialized training on the use of IDSS in the context of hotel services, thus facilitating data exchange and enhancing supply chain agility. Some hindrances need to be approached to facilitate the adoption of IDSS in hotel supply chain management, namely: the complexity of IDSS technologies (Wyers, 2019) and the time required to plan and implement this technology (Sabeti *et al.*, 2019). Further challenges that the forthcoming adoption of IDSS may pose in the hotel industry are related to data security and privacy. This was also supported by other researchers (Karame and Androulaki, 2016; Kshetri, 2017; Tofighi *et al.*, 2018). The technological and analytical capabilities of hotels are varied widely. For effective IDSS adoption, it is necessary to form a multi-skilled team and to collaborate the different elements within the hotel. Also, issues such as data sharing culture and incentives should be considered. The second hurdle is that IDSS is one of the initiatives that require a relatively long time and include different phases of development, experiment, and implementation. It may be noted that the engagement and constant support from the top management are required to implement IDSS, which may take from a year to a year and a half. Furthermore, collecting data from different departments, combining, validating, and tracking development together is an irksome activity (Arunachalam *et al.*, 2018).

In terms of the practical implications, this study provides a new model for hotel supply chain management by incorporating IDSS as shown in Figure (5).

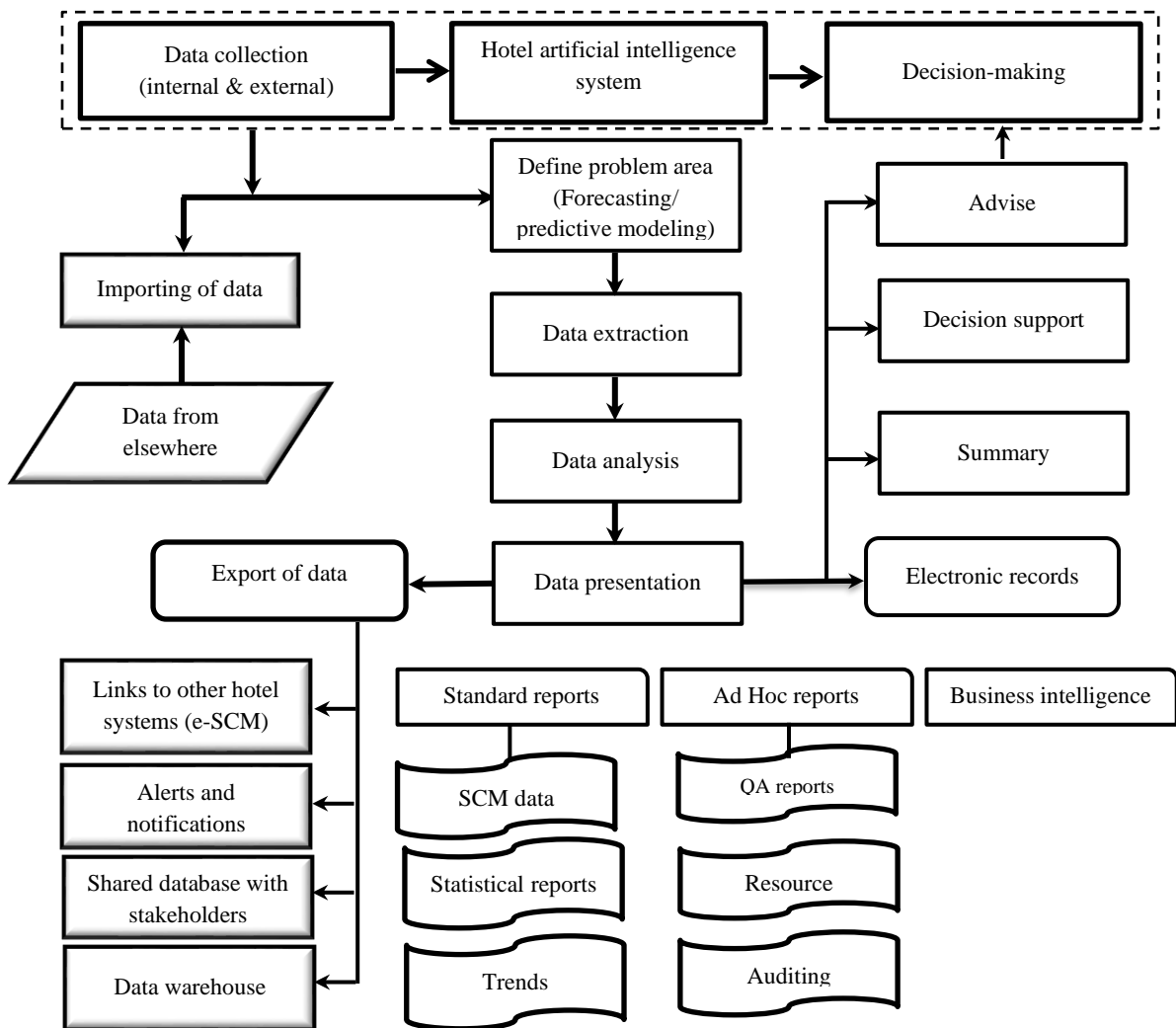


Fig.4. A schematic diagram of the IDSS adoption framework
(Arrows indicate the flow of information)

Conclusion and future perspectives

IDSS technology is gaining increasing interest across the various industrial and service sectors. Given the vast resources in the hotel sector, this technology has the potential to greatly benefit the hotel supply chain, as it can contribute to making the right decisions in many uncertain situations along the supply chain. Yet, to date, no attempt has been executed to explore the predisposition of this sector to adopt IDSS technology. Therefore, this study provides insights for hotels in Egypt regarding the factors that might affect the use of AI in supply chain processes and it also sets the grounds for hotels to assess their readiness for future IDSS adoption. The findings from this study are especially important for hotels that are willing to embrace and adopt innovative technologies within supply chain operations. The study provides support to understand implications related to IDSS adoption. Managers can be

equipped with a more holistic perception of inherent challenges related to IDSS adoption that hotels are likely to face. Such perception will allow them to grasp the critical factors that should be addressed within their initiatives to adopt IDSS. Eventually, this study recommends that extra consideration should be given to the inherent technological and organizational indications of such adoption for supply chains.

Although there are good results for the current study, it should be perceived that the data collected is mainly from hotels located in major cities in Egypt and the number of investigated hotels is relatively small ($n = 70$). Also, although the respondents are familiar with the topic of the study, some of the responses were primarily cognitive. These limitations must be kept in mind when analyzing and interpreting the results of this study. Future studies should look more specifically at the applications that can benefit hotels in providing data sources and analytical capabilities, and how these technologies can be integrated into existing supply chain practices.

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تحويل سلسلة توريد الفنادق باستخدام نظام دعم القرار الذكي: الآفاق والتحديات

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المفص

تقود الابتكارات التكنولوجية الحديثة الاتجاه إلى رقمنة سلاسل التوريد الفندقية. أشهر التقنيات وأكثرها استخدامًا هي الذكاء الاصطناعي والروبوتات وإنترنت الأشياء (IoT) والحوسبة السحابية و blockchain والتحليلات التنبؤية المتقدمة. توفر هذه التقنيات الأدوات التي يمكن أن تعيد تشكيل وتصميم العديد من جوانب سلاسل التوريد الفندقية. تهدف هذه الدراسة إلى استكشاف الفرص ورسم المسار لاعتماد نظام دعم القرار الذكي (IDSS) في إدارة سلسلة التوريد الفندقية. IDSS هو نظام قائم على الكمبيوتر يساعد في عملية صنع القرار من خلال إنشاء بدائل مقبولة، والتي يمكن بعد ذلك تقييمها باستخدام مجموعة من الأنماط المحددة مسبقًا لاتخاذ قرارات موثوقة وقائمة على الحقائق. ولتحقيق هذه الغاية، شاركت هذه الدراسة في 12 دراسة دلفي مع مديري الفنادق وخبراء الصناعة الرئيسيين في مصر، وتلقت مدخلات إضافية من 70 استبيانًا منظمًا تم إجراؤه بين فنادق من فئة أربعة وخمسة نجوم في مصر مما يسمح بإلقاء نظرة أعمق على السيناريوهات المحتملة لكيفية تطبيق IDSS في إدارة سلسلة التوريد الفندقية. كشفت النتائج عن أن سلاسل التوريد الفندقية في مصر تتجه نحو التحول الرقمي، وإن كان ذلك بخطوات بطيئة. كما كشفت النتائج أن جودة البيانات وإمكانيات اتخاذ القرار التحليلي والتأثيرات التحويلية تبدو عوامل حاسمة تؤثر على تبني IDSS. تتمثل إحدى النتائج الرئيسية لهذه الدراسة في أن الفنادق المصرية لا يمكنها جني ميزة التكامل لتكنولوجيا IDSS دون مشاركة إضافية بين شركاء سلسلة التوريد.

معلومات المقالة

الكلمات المفتاحية

التحول الرقمي؛
سلسلة التوريد؛
IDSS؛ قطاع
الفنادق؛ مصر.

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