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Effects of management practices for using the SaaS system on performance of hospitality firms in Norway

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ABSTRACT

The earlier literature either measured management practices in terms of the general management traits or did not account for the effects on firm performance. However, the transformation of the Enterprise Resource Planning (ERP) systems from general to more specific practices, the counteractive managerial goals and standardization and measurement issues requires the measures with more specific goals in a specific setting. The current paper aims at filling the gaps in measuring management practices and its effects on production costs and technical efficiency using daily data of 92 hospitality firms, i.e. chain hotels, in Norway from 2012 to 2014. We measured management practices in an index constructed from multiple criteria that capture managers' user patterns of the software-as-a-service (SaaS) systems. The empirical model identified inefficiency using a translog stochastic frontier input distance function (IDF). The findings show, on average, a 10% improvement in management practices increases production costs by 1.2%, but it improves efficiency by 0.9%. However, the marginal effect of improved management practices on the production cost is found to be U-shaped, while the marginal impact on inefficiency gradually declines to zero. The study also provides managerial implications on how to effectively use the ERP system and improve firm performance.

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1. Introduction

The hospitality businesses face a number of challenges to improve their performance. From a productivity perspective, hospitality firms strive to align staffing with a stochastic demand. Under staffing can lead guests waiting in lines during check in and in other service encounters. Conversely, firms loose money having too many staff on the job relative to the number of guests. Along with the intertwined staffing challenge of maintaining a desired service quality level, maximizing staff productivity is a key operational challenge hospitality firms face and, consequently, has been extensively studied (e.g. F. Tan & Netessine, 2014;

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T. F. Tan & Netessine, 2014). Enterprise Resource Planning (ERP) systems designed to match booking forecasts with recommended staffing levels now support managers in many hospitality businesses in employing staff more efficiently. However, managers may not always properly understand how to best employ these ERP systems and the recommendations they provide. Unless information technologies are backed by good management practices, their deployment is not a guarantee for success. The emergence of the productivity paradox is a testament to this challenge, namely, that information technology is not always followed by the expected productivity increases (Brynjolfsson, 1993; Brynjolfsson et al., 2019). To investigate how management practices in hospitality mediate performance effects of information technology, this study offers novel insights by analyzing how managers interaction with a dedicated hospitality ERP system influences productivity outcomes.

The productivity challenges facing hospitality businesses are significant (Pappas & Bregoli, 2016). Globally, the intense competition among hospitality industries, growth of innovations, including the emergence of sharing platforms pressure and the profitability of all these businesses. Furthermore, demand shocks caused by terrorism, pandemics, economic crises, climate, and other events imply hospitality businesses must reconsider strategies of what constitutes optimal staffing levels. More localized demand shocks are equally challenging for hospitality firms. Xie and Tveterås (2020) for instance found the crude oil price decline stripped away business travelers' demand, while it boosted leisure demand in the hospitality sector in Norway. The mismatches between demand and supply of services imply additional costs from either the production or inefficiency in the resource use. In the Nordic context, high labor costs remain a challenge for a hospitality industry that is critically dependent on staff to ensure proper service delivery and customer satisfaction (Alemayehu, 2020). The crunch between the downward pressure of competition on revenue and high costs, therefore, has made it particularly relevant for Nordic hospitality businesses to streamline operations. It follows that learning how to manage and to execute on the information provided by the ERP systems is key to performance.

A few studies (Buhalis & Leung, 2018; Ip et al., 2011; Karadag & Dumanoglu, 2009; Law et al., 2014) investigate management practices and how these differ to explain the information technology productivity paradox in hospitality (Karadag & Dumanoglu, 2009; Sigala, 2003). The findings from these studies suggest that managers' ambitions, attitudes, or reluctance as the reasons for the paradox, and hence, the sub-optimal benefits received from these systems. However, the challenges to measure management practices complicate studying how management practices influence productivity (costs) because of unobserved managerial quality (e.g. Delis & Tsionas, 2018; Siebers et al., 2008; Syverson, 2011). A study by Siebers et al. (2008) show mixed evidences on the effects of management practices on firm performance, implying that it can improve, worsen, or fail to influence the firm performance at all. However, the challenges of how to measure these management-technology interactions remain despite efforts made to tackle the measurement issues with methodological innovations. The empirical applications in both manufacturing and few service sectors indicate that it can be fruitful to explore different approaches to measure management practices in a specific setting based on a specific management goal.

With this background, the current study aims to measure the effects of management practices on production costs and technical inefficiency using daily data of 92 hospitality firms from 2012 to 2014 in Norway. The ERP in question is a software as a service system

(SaaS) system employed by all hospitality firms in the sample. The management practices are measured in terms of how well the firms employ the SaaS system based on 10 indicators with scores ranging from 0 to 10 usage metrics, reported by the software to the supplier. The 10 indicators are aggregated into one index. Higher index values show better use of the SaaS system, following best practices more closely. The production costs are measured in terms of inputs over use, which is estimated as the difference between the the best and actual IDF technology, while inefficiency is determined as the amount over and above the the actual costs (Kumbhakar et al., 2015). The findings show that hospitality firms with improved management practices, on average, incur higher production costs but became more efficient. The findings show the marginal effects of both production costs and technical inefficiency varies with the level of management practices.

The current study contributes to the literature in a number of ways. Primarily, the study provides an application of the new economics of management in a hospitality setting. The literature has expanded to the service sector, but it is also relevant to study the effects of management practices in a labor-intensive and for-profit industries. To our knowledge, this study is the first empirical work of its kind that attempts to explain performance differences pertaining to management practices. Further, the measure of management practices provides a different setting in being targeted toward a specific purpose – a productivity improvement, rather than a general management traits. The study signifies the transition in the measure of management practices to the aspect of more specific innovations and technological changes toward a more SaaS solutions.

Methodologically, the study introduces a unique measure of management practices using a tailor-made software system while also addressing the standardization issue behind the ERP inputs, including the infrastructure, training on how to operate the software system. All the firms considered in this study use the SaaS, limiting the differences and the effects of the software use only to the internal management practices. The criteria for measuring the management practices have been designed by the SaaS developers who are themselves industry experts. This process allows the software's proprietors to compare best-practice across the hospitality firms that employ it. The software is also advantageous in addressing measurement difficulties of management practices in automatically reporting the managers' behavior (i.e. in terms of the degree of software functions utilization as a decision support system) and the results on a daily basis, based on the criteria recommended by these experts. In addition, these features make the data more reliable and be free from psychological biases of self-reporting and non-response rate, although we received the data from secondary sources. Besides, the odds of these data to include erroneous information is minimal, because of its link with the firms' operations and decision making. Practically, the study provides managerial insights to stakeholders (property owners, managers, and investors) for improving the performance of hospitality operations. Managers may understand the daily management practices in their own setting but not in comparison with their competitors, and they may not be fully aware of the the extra production cost and waste of resources (inefficiency) that each level of sub-optimal management practice yields. The owners and investors draw a lessons that would enable their staff selection and recruitment systems reap the benefits of ERP investments.

The remainder of the paper is organized as follows. Section 2 provides the the review of related literature. Section 3 provides the theoretical model in an input distance function (IDF) framework, highlights the key parameters of interest, and explains how the IDF estimation is conducted using the maximum likelihood method. The section also provides data and descriptive statistics. Section 4 presents the empirical results, a discussion of key findings, and implications, while Section 5 winds up the paper with some concluding remarks.

2. Literature review

Since the seminal study of Mundlak (1961), a growing literature has been concerned with measuring and explaining management practices' effect on productivity. As these attempts evolved, they formed the new empirical economics of management literature, which is devoted to measuring productivity differences based on comprehensive cross-country, industry levels as well as firm-level management surveys (Bloom et al., 2007; Bloom & Van Reenen, 2010). However, these authors point out the challenges of survey data in addressing the measurement errors, because of the psychological bias and non-response rates involved. In addition, these studies attempted to address the general management traits and best practice, which may not be the most relevant for drawing managerial implications on the firm's specific purpose. Other related studies also attempted to address the measurement issues using more advanced econometric methods such as stochastic production frontier and semiparametric approaches (e.g. Triebs & Kumbhakar, 2018) and Bayesian econometrics (Delis & Tsionas, 2018). Further, the attempts to control for the measurement errors have also led to more advanced methodological approaches of Bloom et al. (2013), who implemented a randomized controlled trial in an Indian textile manufacturing industry using a free consultancy service on lean management as an intervention. Although these approaches have strong merits or are the ideal in capturing measurement errors, these evidences are either limited to the manufacturing sector or they may not reveal new insights on the effects of management practices based on a specific goal. Besides, the gaps in the hospitality and tourism literature, this makes it more intriguing to conduct the research in this setting.

Scant literature extended this research to the service sector, namely, education (Bloom et al., 2015) and health care (McConnell et al., 2013; Tsai et al., 2015), but the industries in the service sector naturally differ in several ways, including labor and technological intensities and customer orientation. The business goals and styles of management as well as the productivity and efficiency implications might also differ. Besides, there is an extensive literature that investigates the ERP systems' use and roles in the service sector (Botta-Genoulaz & Millet, 2006; Shehab et al., 2004). In hospitality, these roles concentrate on improving human resource management (DiPietro & Wang, 2010), quality management, customer relationship management, and efficiency (Daghfous & Barkhi, 2009; Ruiz-Molina et al., 2011) and draw implications for the more effective use of these systems. More close to our study are the studies by Obonyo et al. (2016, 2018), which conduct an exploratory study on the relationship between the management practices and the actual use of information technology systems among Kenyan hotels but the the measure of the effects on firm performance are lacking in these studies. The intuition behind the research effort on measuring the effectiveness of management practices is its impact of firm performance, but the topic has received little attention in the ERP systems literature in general and in hospitality in particular.

ERP is defined differently by different authors depending on the information technology system's purpose and the level of its innovations at the time. Botta-Genoulaz and Millet (2006), for instance, define it as a computer system that collects information from various departments and functions to help managers in decision-making. This definition seems to link the ERP only to operational purposes and the internal flows of information. But Y. C. Wang and Qualls (2007) regard the information technology systems as a strategic input, emphasizing its strategic role compared to the operational one. More broadly, Chauhan and Singh (2017) define ERP as software systems integrated into business strategy and operations for achieving some goals.

The contemporary hospitality literature (e.g. Hughes & Moscardo, 2019; Khatri, 2019; Peter, 2008; Ruiz-Molina et al., 2011) widely recognized the extensive application of the ERP systems and others predict its growing role in the sector in the future. For instance, Buhalis and Leung (2018) argue the future hospitality is believed to be more likely become "smarter and agile". Hughes and Moscardo (2019) similarly forecast a paradigm shift because of the extensive use of these technologies and the networks of information flow. Gjerald et al. (2021) and Falk et al. (2021) also regard the interactions of innovations in ERP and hospitality as the key area of future research.

The measurement difficulties of information technology inputs and outputs complicate the relationship between productivity and information technology investments (Sigala, 2003). Besides, the rapid growth of innovations in the information technology, such as cloud computing, artificial intelligence, and service robots, increased the role of ERP in business transformation, specifically in hospitality (Buhalis & Leung, 2018; Jabeen et al., 2022; Law et al., 2014; Tuomi et al., 2021). These innovations also transformed the ERP systems from general to more specific ones (Pavlatos & Paggios, 2008), highlighting a more fruitful implementation and evaluation of management practices in that specific context. The big data analytics and artificial intelligence are the the new developments that extended the horizon of ERP into forecasting the future based on historical trends. Zhang et al. (2015) argue that hospitality managers benefit from such systems in getting forecasts of trends in demand, occupancy rate, yield, labor costs, and other key information for decision-making. Other researchers similarly shed light on its role in supplying managers with the information on customers, marketing, and management forecasting (Buhalis & Leung, 2018; Daghfous & Barkhi, 2009; Lv et al., 2022; Ruiz-Molina et al., 2011; Zhang et al., 2015), customer management (Hughes & Moscardo, 2019), and other relevant information from external sources including events and economic situations (Buhalis & Leung, 2018). The SaaS system, which is used in the current study as an ERP system, is similarly a decision-support system powered by big data analytics for forecasting demand (regarding guest hotel bookings, sales of food, and other hospitality services), and planning the inputs and costs using the forecasts.

Recently, Jabeen et al. (2022) argue that hospitality and tourism businesses in general do not have problems in proactively adopting such new technologies (e.g. software systems) but their barrier for reaping the benefits lies in following up the proper implementation of the software systems. In line with this, Ip et al. (2011) recommend "··· hospitality managers have to understand the potential advantages of ICT applications, and devote their time and effort to taking advantage of new technologies." The ERP literature also explored different mechanisms in which business organizations exploit the potential benefit of ERP and achieve the aforementioned goals and most of them theoretically recommended effective management practices (Law et al., 2014).

So far, the ERP literature has focused on exploring the relationship between access to software systems and the effects, but not in measuring the differences in the software systems' implementation and organizational performance, which the current study adds to the literature. The current study fills the gap in the hospitality literature on how and by how much the differences in management practices influence firm performance.

2.1. Hypotheses testing

The resource-based view theory of firms (Barney, 1991) show the ownership of resources, such as the SaaS systems, along with other physical and human resources are important in determining performance and competitive advantage. This approach is also inline with the second generation of management accounting literature (Nixon & Burns, 2012). With the same motivation, firms invest a significant amount of money in the development of software systems or access and implementation of those already developed systems (Azevedo et al., 2012). As it is explicit in the definition of ERP by Chauhan and Singh (2017), the essence of adopting the systems is to achieve competitiveness. Besides, business organizations implement the systems to pursue more specific goals, such as improving productivity, efficiency, quality, customer satisfaction, and profitability, to achieve the competitiveness goal. The literature argues that the organizations try to achieve competitiveness through better market and customer information and to use this information in decision-making (Buhalis & Leung, 2018), to improve efficiency and customer satisfaction (Law et al., 2014), productivity (Jabeen et al., 2022), or in reducing the costs (Law et al., 2009). But, note that we limit these performance measures to costs and efficiency throughout this study to align with the purpose.

However, the theory of dynamic capabilities (Teece (2010, 2018); Teece et al. (1997)) show that it is not these resources that directly improve firm performance, but the dynamic capabilities that these firms build from the resources over time. According to Teece (2010), dynamic capability refers to the ability of firms to integrate the available resources to achieve organizational goals while also adapting to the dynamics of the business environment. Similarly, Law et al. (2014) support this statement stating that effective management practice should follow up on innovations and integrate them into the business operations and missions. De Leeuw and Van Den Berg (2011) adapt these capabilities to the ERP system context and put them forward as the ability to provide timely, accurate, and reliable data and use them effectively to understand the business dynamics within the required ethical framework. That means the theory emphasizes that it is not only the access to the SaaS system that matters most for the success of firms in improving their performance. Recently

Busulwa et al. (2022) emphasize that it is important for managers to update their capabilities sustainably inline with the digital transformation to lead their organization to improved performance, but it is these capabilities in updating the software timely with accurate information and properly using information from the software for business decision making.

De Leeuw and Van Den Berg (2011) argue that management practices influence individual behavior and the individual behavior shapes to what extent the firm achieves performance goals. These findings link firm capabilities to management practices. In line with the ERP literature, Elbashir et al. (2021) argue the proper software use reflects its integration into the organizational goals and the desired performance outcomes. That is, the appropriate use of such systems minimizes redundancies, duplication, and unnecessary processes.

The SaaS software system provides forecasts of demand and resource requirements to support managerial decision-making uniformly to all clients, but because of the differences in these capabilities, not all firms achieve the desired performance goals in terms of costs and efficiency in resource utilization. The firms reap the benefits regarding the degree to which their management practices were effective. That means that firms that successfully integrated the SaaS system to their missions and wider decision platforms will be able to achieve their performance goals, while those that did not perform well in this regard will not fully achieve them.

In the context of this study, management practices are defined as the working methods that managers use when interacting with the ERP system. This is a set of narrow practices and procedures defined by the supplier of the SaaS system. Specifically, the working methods relate to what the SaaS supplier considers best practices in the employment of the ERP system. Although representing a narrow set of practices these working methods are presumably important, as discussed above. The hospitality managers we study are the gate-keepers and users of the ERP systems and are responsible for staffing decisions. Therefore, the working methods the managers adopt when using the ERP system should matter.

The difference in implementing these systems might depend on the natural talent of managers to motivate employees and lead them to achieve the organizational goals (Buhalis & Leung, 2018; Peter, 2008). The empirical evidence from the new economics of management (Bloom et al., 2007; Bloom & Van Reenen, 2010) also supports these differences. Azevedo et al. (2012) also elaborate on the efficiency role of ERP as "systems enable a control and reduced losses due to inefficiency reconciliation and duplication of work, and possible delays that finally enhances the overall performances of services to the consumer." Other studies also support this argument as inaccurate information yields inefficient resource utilization (Chan et al., 2005; Defraeye & Van Nieuwenhuyse, 2016; Hur et al., 2004).

Therefore, we hypothesize that effective management practices enhance firm performance. Specifically,

(1) Improved management practices dampen production costs as these firms will be in a better position to produce the same service at a lower cost.
(2) Improved management practices enhance technical efficiency, reducing waste, and ensuring more effective resource utilization.

3. Methods

3.1. Data and summary statistics

The analysis is conducted using the daily of data 92 hospitality firms, i.e. hotels with (without) a restaurant that belong to three chains. One is a multinational hotel and the remaining are national chains. The data cover the period from May 2012 to September 2014. These data were received from a provider of a SaaS productivity management tool for hotels and restaurants.

The hotels with a restaurant account for about 83% of total sample. The sample firms are distributed over all the typologies of hotels; small Metro/Town (30%), suburban (24%), urban (42%), and airport (4%). These sample firms also represent all Norway's regions, counties, and cities. The sample covers all the five regions, with the Eastern part taking the larger share and while the mid-Norway and the southern regions sharing a smaller percentage, as illustrated on the left panel of Figure 1. They also cover almost all the cities of Norway, with relatively larger shares located in Oslo, Bergen, and Trondheim, and Stavanger (see the right-panel of Figure 1) in accordance with the natural flow of businesses in the country because of agglomeration and other pull factors. Similarly, the larger share of the Eastern region might be attributed to the higher density of firms in the Oslo area, as the capital city. Besides, anecdotes show that these hospitality firms are of three to five star hotels and a larger share of hospitality firms in Norway use the SaaS or various SaaS-like software systems for different purposes, including revenue management. We do not have the data and statistics to discuss these issues in detail, but from the general trend, we understand that the decision-making in hospitality is

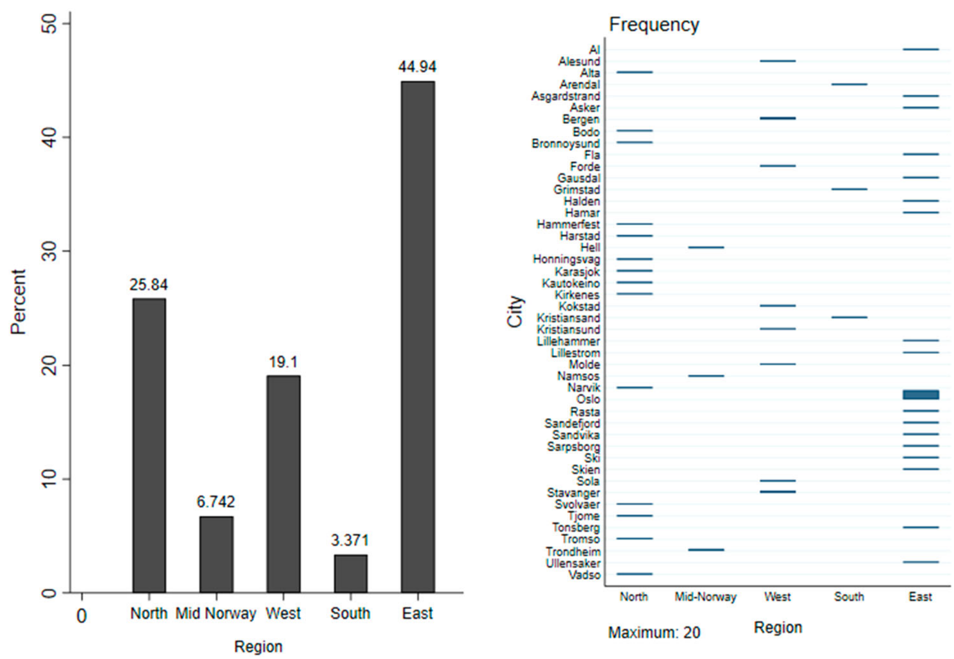

Figure 1. The distribution of sample hospitality firms among regions (a) and among cities in each region (b).

increasingly integrated into the ERP system not only in Norway but also around the globe, as thoroughly discussed in Section 2. Thus, our study will provide a case example to show the effects of management practices among firms using the SaaS software system in Norway.

Also, the study period from 2012 to 2014 is well situated relative to the 2007/2008 global financial crisis and we do not need to account for shocks in modeling as it took Norway only a year to recover from the impacts .[1] Although the speed of recovery among firms varies, these differences will be captured using the technical change in our analyses.

Although the data set is obtained from a secondary source, the data on the measures of management practices can be judged reliable on different grounds. First, the data were collected based on hands-on data reported on the daily hospitality operations using the SaaS productivity management tool. As part of the decision support system, the software reports the clients' access to the different built-in functionalities, the degree to which they followed the suggested recommendations, and their software usage patterns to the supplier. To obtain the SaaS tool's full productivity benefits, clients must share accurate information with the system; otherwise, they will be subject to the garbage-in garbage-out problem. The SaaS tool works with a flow of information where the daily performance data are inputs for demand forecast, which, in turn, becomes an input in management decisions that involve looking ahead. The SaaS tool supplier also tries to ensure the clients' satisfaction by providing accurate information and creating the right decision-making platform.

The SaaS tool usage provides a relevant context for measuring and analyzing management practices because all the 92 firms have access to the productivity tool over the entire study period. Moreover, SaaS tool management practices' observations are sufficiently diverse to create a meaningful variation to analyze. In other words, the data seem to identify both "good" and "bad" managers. The assumption behind the identification of good and bad practices is that the management approach impacts individuals' behavior, and helps the organization achieve the performance goal(s) (De Leeuw & Van Den Berg, 2011). The challenge in measuring management practices lies in its being based on subjective criteria, because of behavioral traits as well as its variation according to the contexts of application (Bloom et al., 2012). To address these measurement issues, Bloom et al. (2007) used the best practices that were suggested by experts and a similar approach is applied in this study. In practice, this means the SaaS productivity tool suppliers are experts in their intimate knowledge of the hospitality industry's software tool and operations. These experts developed 10 criteria based on the frequency with which the software was accessed and how often the relevant information was updated and used (e.g. forecasts of key performance indicators, such as budgets and labor hours). The criteria also include the credibility indicators of productivity, food costs, and sales. Note that the authors could not explicitly list these criteria because of ethical issues and sharing rights but provided a summary of the content. Each criterion was given a score from zero to 10, with 0 representing the "worst" and 10 representing the "ideal" practice. Notably, these measures' calculation is integrated into the SaaS tool, where they are updated daily. These 10 indicators are captured aggregately in the management practices index, M_{it}, which summarizes how well clients use the SaaS tool. Thus, the data collection method is innovative and captures highly specific management practices in hospitality operations.

Table 1. Summary statistics.

Variable	Definition	Mean	SD	Min	Max
Inputs					
M	Management practices index	8.02	1.14	1.96	10.00
x_1	No. of available rooms	151.78	78.83	23.00	435.00
x_2	Labor hours	166.41	140.39	0.54	872.67
y_1	Food and beverages	24398.41	26920.90	1.69	237333.10
y_2	Room service	87511.34	62947.94	158.00	509812.40
y_3	Other sales	42460.80	49950.30	112.51	457481.60
y	Total revenue	154370.50	117852.40	733.46	701577.10

Note: In total, there are 52,358 observations. These variables were transformed into natural logarithms for use in the empirical model.

Other variables described in the empirical model are defined as follows. Capital stock,x_1, is proxied by the number of available rooms because it represents the size of other complementary fixed inputs. Although the study employs daily data for other key variables, the number of available rooms is fixed over time, and can represent the fixed assets, as used in several hospitality studies (e.g. Assaf et al., 2010; Barros, 2005). Besides, meeting space would have been a potential measure of capital stock, but we could not use this because several hotels and restaurants do not provide meeting or conference services. Labor, x_2, is measured in terms of the number of quality-adjusted hours to account for heterogeneity. The quality adjustment is conducted using a Divisia index (Solow, 1957), where the average wage rate in each department as a proxy of labor quality. This measure is advantageous over the sum of labor hours because hospitality firms often hire heterogeneous labor groups. Outputs were measured as revenue in Norwegian kroner(NOK), following Syverson's (2011) recommendation. There were three output measures based on revenues from food and beverage sales, accommodation, and sales of other goods and services. The data also contain observations for the annual trend from 2012 to 2014, the dummies for hotel chains, and firm ID represented by $\tilde{t}$, chain, and hid.

Table 1 provides summary statistics. On average, the firms under consideration implement 80 % of the best management practice daily. These firms have the capacity of 152 rooms and employ 166 hours of adjusted labor per day. They also earn about 16, 57, and 28 % of the total daily sales from food and beverages, accommodation, and other services.

3.2. Input distance function

After measuring the management practices based on how well the firms used the software, we now explain how the differences in management practices might influence production costs and technical efficiency in an IDF framework. The theory of the IDF was introduced by Shephard (1953) and was more popularized later by Färe et al. (1994) and Kumbhakar and Lovell (2003).

An advantage of the distance function is that it allows for technologies with more than one output type. Our empirical model exploits this advantage by implementing the estimation of the three outputs described in Section 3.1. It also measures production costs using the inputs (technology) without the need for the price, which is challenging to identify in multi-output producing industries. Finally, the IDF methodology matches the decision-making process in the service industries because variables over which firms exert influence are identified while controlling for variables beyond their control. For instance, the destination characteristics such as tourism amenities, natural attractions, location in a metropolitan, or higher population density areas are among the determinants of demand for hospitality services, external to firms (Morikawa, 2011, 2012). However, firms can forecast demand, calculate the probability of selling the service, determine outputs, adapt the inputs, and make them available ahead of time (e.g. Duncan, 1990; Gaynor & Anderson, 1995). Studies like Choi et al. (2009) also show the adoption of the hospitality cost optimization approach.

In a situation where forecasted and actual demand deviate, the inputs made available in advance might perish, increasing the production costs and inefficiency. A key motivation for using the SaaS productivity management tool is to minimize such resource misalignment. As a result of having limited influence over demand, the management practices measures based on the SaaS tool use should be evaluated in terms of input minimizing rather than a revenue-maximizing behavior. It is precisely this input-minimizing objective that can be accommodated by applying the IDF framework.

Consider an IDF represented by D_{it} as a function of two inputs, capital, x_{1it} and labor x_{2it}, given the output levels,y_{jit}, where i, t, and j represent the hotel id, time measured in days and the number of output categories, and $j = 1, 2, 3$:

$$D_{it} = A_{it}(F(y_{jit}{:}x_{1it}, x_{2it}). \tag{1}$$

Note also that we use $\tilde{t}$ to differentiate the the annual trend from the time measured in days (t) throughout the paper. As $F(.)$ is homogeneous of degree one in input quantities, we can divide both sides of (1) by one of the two inputs, say, x_{1it} and transform it into a logarithmic form. On the right-hand side, the ratio of capital and labor, $\ln \tilde{x}_{2it}$ replaces x_{2it}. The model also includes the logarithms of outputs $\ln y_{jit}$, and the shift parameter A_{it} which includes technical inefficiency, u_{it} and random noise, v_{it} (Kumbhakar et al., 2015). The IDF in the log is written as

$$\ln x_{1it} = F(\ln y_{jit};\ \ln \tilde{x}_{2it}, M_{it}, \tilde{t}, chain) + v_{it} - u_{it}. \tag{2}$$

We represent the IDF model in terms of the flexible translog function. The model assumes symmetry, which implies that $\beta_{\ln \tilde{x}_2 y_j} = \beta_{y_j \ln \tilde{x}_2}$, $\beta_{\ln \tilde{x}_2 M} = \beta_{M \ln \tilde{x}_2}$, etc., as shown in (3), where the subscripts show the respective variables.

$$\ln x_{1it} = \beta_0 + \beta_{\tilde{x}_2} \ln \tilde{x}_{2it} + \beta_{y_j} \ln y_{jit} + \beta_M M_{it} + \beta_{\tilde{t}} \tilde{t} \tag{3}$$

$$+1/2\beta_{\tilde{x}_2} \ln \tilde{x}_{2it} + 1/2 \sum_{j=1}^{3} \beta_{y_{jj'}} \ln y_{jit}. \ln y_{j'it} + 1/2\beta_{MM} M_{it}^2 + 1/2\beta_{\tilde{t}} \tilde{t}^2 \tag{4}$$

$$+\beta_{\tilde{x}_2 y_j} \ln \tilde{x}_{2it}. \ln y_{jit} + \beta_{\tilde{x}_2 M} \tilde{x}_{2it} M_{it} + \beta_{\tilde{x}_2 \tilde{t}} \tilde{x}_{2it} \tilde{t} + \sum_{j=1}^{3} \beta_{y_j M} \ln y_{jit} M_{it} \tag{5}$$

$$+ \sum_{j=1}^{3} \beta_{y_j \tilde{t}} \ln y_{jit} \tilde{t} + \beta_{M\tilde{t}}.M_{it} \tilde{t} + chain + v_{it} - u_{it}. \tag{6}$$

The maximum likelihood (ML) estimation method identifies the inefficiency term and estimates the determinants. In the ML, we assume that the inefficiency term u_{it} is half-normally distributed $N^{+}(u_{it}, \sigma^2_{uit})$, and the random noise, v_{it}, is normally distributed: $v \sim i.i.dN(0, \sigma^2_{v_it})$. To allow for determinants of inefficiency, we specify:

$$\sigma^2_{u_it} = \exp\left(\phi_M M_{it} + \sum_{k=1}^{2} \phi_k \; Chain + \sum_{i=1}^{91} \phi_i hid\right) + \varepsilon_{it}. \tag{7}$$

Since the study aims to analyze the effects of management practices on production costs and inefficiency in the hospitality sector, it is essential to elaborate on management practices within the empirical model that involves stochastic frontier analysis. The question that needs to be answered is whether M_{it} is the determinant of either production costs, technical inefficiency, or both. Earlier empirical studies have modeled the impact of management practices in different manners. For instance, Bloom et al. (2016) viewed management practices as the determinant of the production technology, i.e. as one of the inputs, while Bloom et al. (2017, 2007) viewed management practices as an environmental variable that determines technical efficiency. Triebs and Kumbhakar (2018) considered management practices as the determinant of both technology and technical efficiency. We follow the three approaches to specify the variable, as the economics of management theory supports all, and use the best model to interpret the results. Chain dummies (*Chain*) are similarly specified as the differences in the management styles across the three chain groups, which may influence production costs as well as technical efficiency. It is assumed that firms in a chain have similar service standards and strategic objectives but the remaining firm-specific heterogeneity in technical inefficiency are accounted using firm dummies (*hid*). The empirical model allows cost differences due to technical changes over time using the annual time trend, $\tilde{t}$.

4. Results and discussion

4.1. Empirical results

This study analyzes how the practices of using a SaaS productivity management tool in hospitality influence production costs and technical inefficiency in hospitality. Within the IDF modeling framework, the key parameters of interest are the marginal effects of management practices on production costs, $\frac{\partial \ln x_{1it}}{\partial M_{it}}$, and the cost elasticities of outputs, $\frac{\partial \ln x_{1it}}{\partial \ln y_{jit}}$. These two parameters capture how variations in management practices (relative to best practice) affect costs and efficiency.

The returns to scale or scale economies are calculated as the sum of the three outputs' elasticities. The coefficients of the chain dummies show differences in production costs across groups of hotels and restaurants. Technical change, $\frac{\partial \ln x_{1it}}{\partial \tilde{t}}$ captures how the cost changes over time. Finally, the technical efficiency is calculated as $TE = \exp(-u)$ and the percentage change in TE is calculated from $100(\frac{\partial \ln TE}{\partial \tilde{t}}) = -100\frac{\partial u}{\partial \tilde{t}}$.

The marginal effects of management practices on the technical inefficiency, $\frac{\partial \ln u_{it}}{\partial M_{it}}$, are estimated from $E(u_{it}) = \sqrt{(2/\pi)}\sigma_{uit}$. See H. J. Wang (2002) on the estimation of the marginal effects. Furthermore, we compute the coefficient estimates of chain and firm dummies. The marginal effects of the continuous key variables are:

$$\frac{\partial \ln x_{1it}}{\partial M_{it}} = \beta_M + \beta_{MM} M_{it} + \beta_{\tilde{x}_2 M} \ln \tilde{x}_{2it} + \beta_{y_j M} \ln y_{jit} \beta_{M\tilde{t}} \tilde{t}, \tag{8}$$

$$\frac{\partial \ln x_{1it}}{\partial y_{jit}} = \beta_{y_j} + \beta_{y_{jj'}} \ln y_{jit} + \beta_{\tilde{x}_2 y_j} \ln \tilde{x}_{2it} + \beta_{y_j M} M_{it} + \beta_{y_j \tilde{t}} \tilde{t}, \tag{9}$$

$$\frac{\partial \ln x_{1it}}{\partial \tilde{t}} = \beta_{\tilde{t}} + \beta_{\tilde{t}\tilde{t}} \tilde{t} + \beta_{\tilde{x}_2 \tilde{t}} \ln \tilde{x}_{2it} + \beta_{y_j \tilde{t}} \ln y_{jit} + \beta_{M\tilde{t}} M_{it}, \tag{10}$$

$$\frac{\partial E(u_{it})}{\partial M_{it}} = \sqrt{(2/\pi)} \frac{\partial \sigma u_{it}}{\partial M_{it}}, \tag{11}$$

where σ_{uit} is given in (4).

Table A1 in the Appendix reports the empirical results for the three alternative ways we model the influence of management practices (i.e. production cost, efficiency, or both). The specifications in models (1) and (2) show the empirical results when management practices are included among the IDF determinants and technical inefficiency. Moreover, the empirical results in model (3) include the management practices as both the determinants of production costs and technical inefficiency. The specifications in models (1) and (3) provide similar estimates regarding the signs, statistical significance, and coefficients' magnitude. The results show that the coefficients are significant at the conventional levels, except for the time trend square's coefficient. However, the results in model (2) differ because of the exclusion of M_{it} from the IDF. In this model, neither of the interaction variables between the time trend,$\tilde{t}$, and $\ln y_{1it}$ as well as $\ln y_{3it}$ is statistically significant.

It is relevant to include management practices as one of the production inputs since it can influence output. In model (1), the estimated management practice coefficient M_{it} was significant at the 10% level, and its interactions with $\ln \tilde{x}_{2it}$ and the time trend, $\tilde{t}$ were significant at less than the 5% level. The coefficients of M_{it} and its interactions with $\ln y_{1it}$, $\ln y_{3it}$, and $\tilde{t}$ were significant at less than the 5% level in model (3). Table A1 also shows that the coefficients of management practices were the same in models (1) and (2), and the effect of management practices on technical inefficiency was quite similar for models (2) and (3).

Furthermore, these models show that all the determinants of inefficiency were statistically significant at less than the 1% significance level, which implies that we can reject the null hypothesis of the stochastic frontier model, i.e. that no inefficiency exists among the hospitality firms, and it supports stochastic frontier analysis as the right approach to address this issue. The chain dummies' coefficient estimates were consistent across these models in both production cost and technical inefficiency. Therefore, we regard model (3) as the main result in this article and base the interpretations on it. Table 2 provides a summary of the key results from the model specification in model (3).

4.1.1. Effects of management practices on cost and technical inefficiency

We test the hypotheses that improved management routines can reduce the frequency and magnitude of input overuse and technical inefficiency (i.e. wastage). Concerning these goals, the key variables of interest are the marginal effects of management practices on the production cost, $\frac{\partial \ln x_{1it}}{\partial M_{it}}$ and the marginal effects of management practices on

Table 2. Summary of empirical results.

Variable	Mean	Std.Dev.	Min	Max
$\frac{\partial \ln x_{1it}}{\partial M_{it}}$	0.0117	0.0271	-0.1248	0.1880
$\frac{\partial E(u_{it})}{\partial M_{it}}$	-0.0088	0.0084	-0.0430	0.0000
$\frac{\partial \ln x_{1it}}{\partial Y_{1it}}$	0.0782	0.0359	0.0000	0.2017
$\frac{\partial \ln x_{1it}}{\partial Y_{2it}}$	0.2433	0.0709	0.0000	0.4854
$\frac{\partial \ln x_{1it}}{\partial Y_{3it}}$	0.0199	0.0166	0.0000	0.1187
RTS	0.3185	0.0938	0.0224	0.5341
$\frac{\partial \ln x_{1}}{t}$	0.0027	0.0120	-0.0731	0.0892
TE	0.7670	0.2087	0.1177	1.00

inefficiency, $\frac{\partial E(u_{it})}{\partial M_{it}}$ (Table 2). The table shows that a 10% increase (decrease) in the management practices index would increase (decrease) the production cost by 1.2%. This result indicates that the production cost is positively associated with the management practices index, i.e. the production cost on average increases (decreases) when the management practice improves (declines). However, a closer examination shows that the marginal effects, $\frac{\partial \ln x_{1it}}{\partial M_{it}}$ differ. An improvement in the management practices index initially reduces the production costs by about 0.66% for the first quartile, but it increases the production costs by 2.93% for the third quartile. Thus, the marginal effects of management practices on production costs are negative, zero, and positive. Figure 2(a) illustrates the distributions of $\frac{\partial \ln x_{1it}}{\partial M_{it}}$.

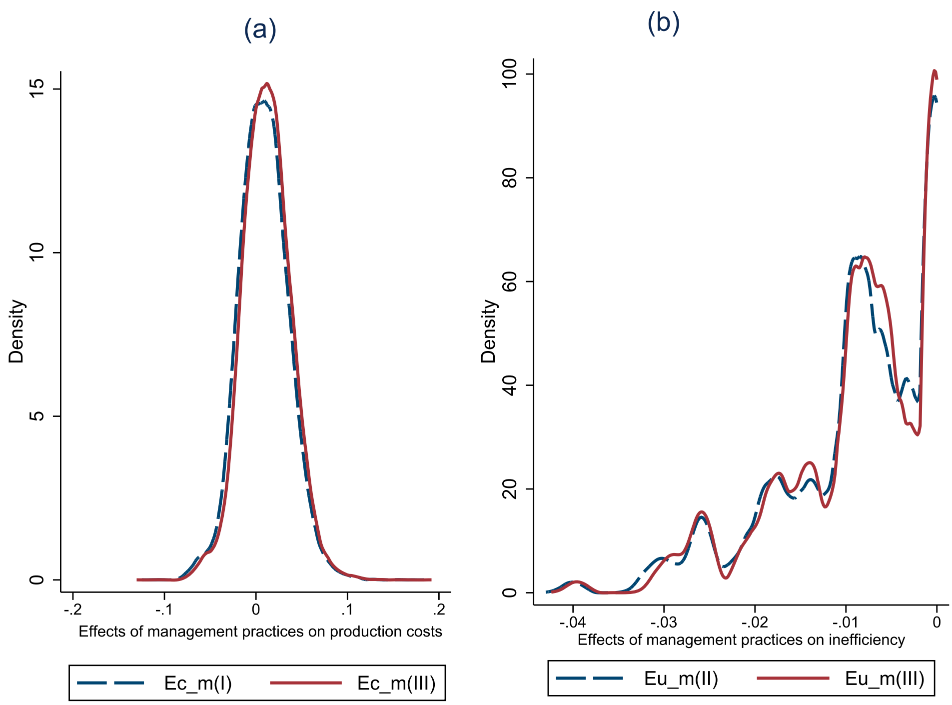

Figure 2. The density distribution of the effect of management practices (M_{it}) on production costs (a) and technical inefficiency (b). The numbers in parentheses refer to the empirical model in Table A1.

This finding indicates that implementing appropriate management practices can initially reduce production costs, but further improvements in management routines after a certain level increase the production cost, i.e. it makes the production technology costlier.

The results also show that the effect of management practices on inefficiency, $\frac{\partial E(u_{it})}{\partial M_{it}}$, is negative and significant at the 1% level. On average, a unit increase in the management practices index yields a 0.9% decrease in technical inefficiency. The marginal effects of management practices on technical inefficiency were heterogeneous: $\frac{\partial E(u_{it})}{\partial M_{it}}$ is negative throughout. In the first quartile, it is 1.33%, and it falls to 0.18% for the third quartile, i.e. the coefficient size gradually declines in absolute terms and ultimately drops to zero for the fourth quartile. Figure 2(b) illustrates the distribution of $\frac{\partial E(u_{it})}{\partial M_{it}}$.

4.1.2. Cost elasticities and scale economies

The summary of empirical results in Table 2 shows that, on average, the cost elasticities of each output (y_1, y_2, and y_3) were 0.08, 0.24, and 0.02%, respectively. Table A1 shows that in contrast to the output elasticities, the input ratio's coefficient estimate,$\ln \tilde{x}_2$, is negative, consistent with the theoretical expectation.

The estimated cost elasticity of outputs for accommodation services is larger than that for food and beverages,y_1 and other sales y_3, but they are small. On average, the sum of these cost elasticities (which is the reciprocal of returns to scale, RTS) is 0.32%, which is very small relative to the optimal scale of operation (RTS=1). This implies that a percentage increase in the three outputs simultaneously increases the production cost by about a third of a percentage. An interpretation is that on average firms' capacity utilization is small compared to the optimum scale since a one percentage increase in outputs yields smaller than one percentage increase in production costs.

4.1.3. Technical changes, chain differences, and technical efficiency

The previous section discussed how marginal effects of management practices differed for the production cost and technical inefficiency. We now discuss technical progress, the technical efficiency scores, and the differences among chains. Table 2 shows that the mean technical change was 0.27%, implying that the hospitality firms underwent technical regress over the study period (2012–2014). However, the variations across this trend were large. The technical change is negative, meaning the hospitality firms underwent technical progress (cost diminution) for about half of the observations, but it becomes positive (technical regress) for the remaining half of the observations. The technical progress tends to be slightly larger than the technical regress and, therefore, on average, the input use of the firms under consideration increased over time, ceteris paribus. The kernel density plot in Figure 3 illustrates these details.

Table 2 also shows that the average efficiency score is about 77%, implying that the hospitality firms examined in this study are quite efficient. However, scores are quite dispersed; for instance, 25% and 75% of the distributions show an efficiency score of 63% and 97%, respectively. The fourth quartile covers fully efficient firms. Therefore, the findings suggest that these firms have some room to improve their efficiency.

Table 3 compares chain hotels and shows that all the chains differ concerning the average production cost and technical inefficiency levels. Compared to Chain 1, the

Table 3. Comparison of chains.

	IDF	σ_u
Chain 2	0.223***	−0.534***
	(0.0038)	(0.1020)
Chain 3	−0.179***	2.148***
	(0.0074)	(0.0989)

Note: These results are extracted from Table A1 in the Appendix and *Chain 1* is the reference group.

hospitality service production in *Chain* 2 is 0.22% costlier, while *Chain* 3 is 0.18% cheaper. The findings also show that *Chain* 2 is 0.53% less inefficient, while *Chain* 3 is 2.15% more inefficient than *Chain*1. Overall, these results indicate that *Chain* 3 has the lowest cost and is the most inefficient, while *Chain* 2 is the costliest and the most efficient chain hotel. These findings accord with differences in service quality and prices among the chains. However, we cannot proceed with any further discussion on the intuitions because of the firms' anonymity.

4.2. Discussion and implications

The findings show that improved management practices, on average, lead to a higher production costs among the sample hospitality firms. This means the findings support one of the hypotheses put forth in the introduction. The finding shows the effects of management practices vary for the different management practices as evident from the estimated marginal effects. Figure 4(a) shows the 95% linear prediction of management

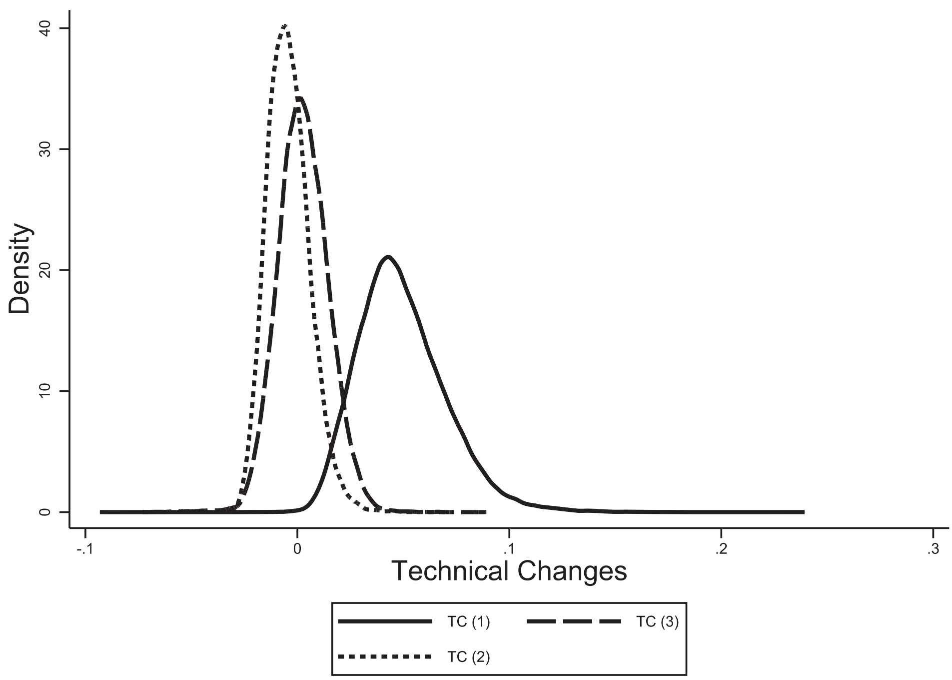

Figure 3. Distributions of technical changes over the period 2012–2014.

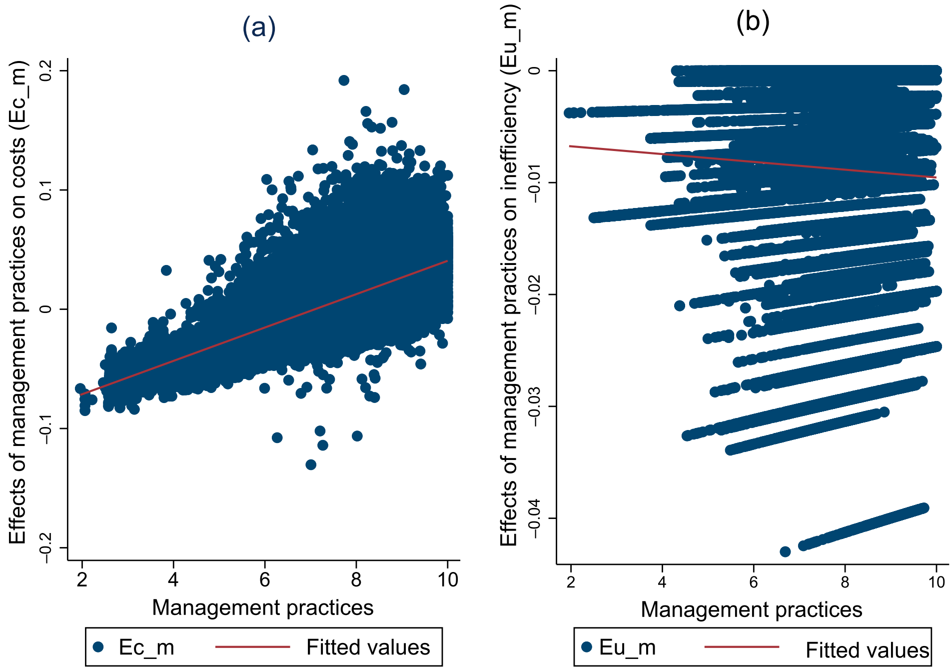

Figure 4. Marginal effects of management practices on production costs and inefficiency.

practices' marginal effects on cost against the index of management practices and reveals that the effect on the production costs take a U-shaped pattern as the marginal effect is negative for smaller indices, approximately becomes zero when the index reaches a value of seven and then becomes positive for the index values greater than seven. Remember the management index ranges from 0 to 10 and with the mean value around 8, the findings seem plausible. As this exceeds seven, the finding that the management practices positively affect the production cost is consistent. The right-skewness of the management practices index is expected in line with Collier and Gregory (1995), which states the management practices and their financial effects are biased toward the best practice.

This finding implies that the production costs initially decline with an improved management practices index, but it gradually reaches the minimum, and then rises. These findings reflect the reality on the ground in the hospitality setting because the degree of cost minimization depends on the level of service quality. Lower tier hospitality services implement improved management practices in order to dampen the costs but those on medium and upper-tiers give more weight to the service quality, and aim at benefit from higher prices, and or increased customer satisfaction and loyalty. Stranjancevic and Bulatovic (2015) for instance argue improved management practices is one of the key inputs to achieve this goal. Bloom et al. (2013) also suggested that improved management practices enhance quality in the Indian manufacturing industry. Although this interpretation goes beyond our study's scope, we believe that those managers who achieve high management practice scores in terms of using the SaaS software have a strong focus not only on reducing the production cost but also on service quality, deliberately limiting the cost savings. This interpretation also accords with David et al. (1996) who found that that service quality consideration may outstrip that of productivity as the most important motivation for hospitality business installing information technology. By better aligning staffing with guest volume enables hospitality firms to deliver more consistent service quality. That means, the rising part of the U-shape of the relationship might reflect high service quality, ceteris paribus.

The diminishing marginal returns to management practices can also be one of the potential mechanism explaining the U-shaped relationships between management practices and costs – i.e. that cost first decrease with improved levels of management practices and then after the latter passes a certain level cost starts to increase. First, the benefits of improved management practices might be reaped quickly, but as the 'low hanging fruits' have been reaped in better management, managers' time required to reach the peak of 'best practice' of using the SaaS productivity tool may outweigh the cost benefits. Diminishing returns to management practices is a standard result in production economics, i.e. improved management increases cost because of the size mismatch. If the firm sizes are not large enough to utilize the full management capacity, maintaining good management routines might lead to greater production costs than benefits.

F. Tan and Netessine (2014) suggested that an inverted U-shaped relationship exists between productivity and input use (for example, staffing), implying that the desirable level is achieved by the joint optimization of cost and quality. The major issue of concern here is how to strike a balance between costs and service quality. The service literature also leaves the optimal trade-offs between the cost of production and service quality as the major area of focus to improve the profitability (Anderson et al., 1997; Baker & Riley, 1994; Brown & Dev, 2000; Choi et al., 2015; Grönroos & Ojasalo, 2004; Klingner et al., 2015; McLaughlin & Coffey, 1990; Parasuraman, 2002; Rust & Huang, 2012; Singh, 2000). Also, a point of caution is that higher tier hospitality services must be extra careful in using inputs sparingly, as cost reductions can deteriorate the level of service quality while those on the lower-tier must do so in using too much of an input not to end up in losses. Nonetheless, this explanation does not rule out the diminishing effects of marginal practices. The rationale for diminishing returns is strong both theoretically and practically since it is easy to imagine situations where hospitality managers use "too much time turning the dials" in the SaaS tool instead of solving other relevant tasks. Therefore, we partly accept our hypothesis on the the cost advantages of improved management practices, but reject it partly as these advantages are reaped quickly and improving the management practices further can subsequently increase production costs.

In contrast, our findings fully support the second hypothesis that improved management practices reduce technical inefficiency. The effect on technical inefficiency also gradually decreases to zero. This is illustrated in Figure 4(b), where the vertical axis, which shows the marginal effects of management practices on inefficiency remain to be negative and zero. This pattern suggests efficiency gains from improved management practices, and the best-practice management practices yield zero technical inefficiencies. Peng et al. (2008) support this finding stating that better organizational routines are the source of competitive advantage, i.e. yields improved efficiency. In line with the objective of the SaaS software systems to reduce the effects of uncertainties from demand fluctuations, the proper management practices and their implementation in terms of forecasting software systems improve the resource utilization in hospitality production. One of the earlier studies (e.g. Morikawa, 2012) also support the finding from this perspective showing the effects of demand fluctuations on the technical inefficiency of service industries, which is the domain of hospitality firms. The findings suggest that hospitality firms that implement better management practices can reduce the inefficiency of inputs use and can reach to the extent of avoiding it.

Revenue management is not the only means for service firms to mitigate the negative effects of demand fluctuations. Now that hotel rooms' online booking services erode economic benefits from revenue management by increasing price transparency, alternative sources of competitive advantages are increasingly important. Improved management practices are essential for the proper management of inputs, i.e. avoiding waste in the production process and maintaining quality. Not the least, in situations with a high degree of demand uncertainty, active management practices are presumed to be particularly important to mitigate the negative effects on the production cost (to some extent) and technical inefficiency. More broadly, an improved input management, through the staff selection and recruitment, motivation, and empowerment of these human resources can make a difference in exploiting the advantages of ERP systems. The heterogeneous effects of management practices can be explained by the theory of the resource-based view of firms (Barney, 1991), which argues that the resources, including human and physical capital, determine firms' capabilities are essential in determining the strategies the firms implement to improve their performance. Arbelo et al. (2021) also show that hotels choose their strategy based on the resources at their disposal and this, in turn, impacts their performance. Interestingly, the choice of management practices is to alien the strategy regarding the choice between cost reduction, quality improvement, or balancing both. The differences among the three chains also support the differences among firms regarding the strategies they follow. These firms include those producing costly service but efficient resource utilization, others with the cheapest service provision but inefficient resource utilization, and those balancing both. Empirically, the heterogeneous cost and efficiency effects of management practices are also in line with earlier studies in this area (Bloom et al., 2017, 2007, 2013, 2016; Bloom & Van Reenen, 2010).

The findings further suggest the sub-optimal size of these hotels (and restaurants), slight technical regress, and the room for further improving their efficiency. These findings also corroborate the results of earlier hospitality studies conducted in the same setting (e.g. Alemayehu & Kumbhakar, 2021; Alemayehu et al., 2022). There can be other potential explanations for the findings on the cost structure, capacity utilization, and efficiency of hospitality firms but scholars regard demand, deliberate overcapacity, and tacit collusion as the main reasons (see Alemayehu et al., 2022 for more details.) First, demand is important for service firms because of service characteristics and the resulting strong ties with performance. Second, hospitality firms put some extra capacity because it is hard to adjust the size of fixed inputs in the short term in case of demand hikes after it is being built or established and second, these firms set excess capacity aside as a mechanism of impacting price and enhancing market power over competitors. Finally, tacit collusion limits capacity utilization to raise the price. One of the potential mechanisms explaining the slight technical regress can also reflect the lagged effect of the 2007/2008 financial crises after the recovery process and the beginning of the oil price decline in 2013/ 2014 (Alemayehu & Kumbhakar, 2021). As a country, Norway did not take a long time to overcome the effects of the financial crises, but within the scope of firms, some recover faster and achieve technical change while others lag and end up in technological regress based on their respective strategies, in line with Arbelo et al. (2021). In addition, the geographical differences in the impacts of oil price decline – more substantial indirect effects in Rogaland county in the Western part of Norway relative to other regions as the business trips made a decline, might also yield heterogeneous technical changes.

5. Conclusions

This study examined the effects of management practices on the production costs (i.e. input overuse) and technical efficiency in an IDF framework. The empirical estimations were based on the data from 92 hospitality firms in Norway, which implemented the same SaaS productivity management tool from 2012 to 2014. The software includes a function that measures how the clients use the software and follow the recommendations. Based on 10 criteria and an index from 1 to 10 developed from these criteria. Thus, the index was used to measure day-to-day management practices in this study.

The findings show the U-shaped relationship between costs of production and the management practices suggesting that the costs initially declines with an improved management practices, but gradually reached a minimum and then starts to rise. Said differently, as the managers start to improve how they use the SaaS system, the production costs first decline, reach the minimum, and then gradually rise for the for the higher end. The increasing costs indicate that an objective of maintaining a defined service quality-level outweighs cost-savings objectives, in line with the findings in David et al. (1996). Nonetheless, the results show that the implementation of improved management practices improves the technical efficiency.

This findings imply that hospitality firms that implemented better management practices in using the SaaS system will be able to improve their efficiency. That means the amount of labor and capital stock employed to produce a given level output is reduced. In practice, the efficiency result is more linked to staffing decisions as the capital stock is largely fixed. It is important to note that the sample firms, on average, had relatively low-cost elasticities, implying sub-optimal capacity utilization, the technical trend pointing to increasing cost levels over the study period, i.e. technological regress. Among the three different chains that the sample of hospitality firms belonged to, one chain had systematically costlier production technology but was the most technically efficient, while another had the cheapest and was the least technically efficient. This means that unit costs and technical efficiency do not have to be aligned in service industries including hospitality because of the costs-service quality trade-offs.

This study is unique in basing the measures of management practices on a specific purpose, in line with the recent developments in ERP innovations, and implementing the data collection on an innovative approach using a tailor-made software that automatically reports to what extent managers updated the software system with the relevant information, accessed forecasts, and used the information as inputs for the daily decision-making based on expert criteria. This process frees the data from bias, non-response, and measurement errors. The study also provides managerial insights on their practices relative to the best-practice users and their effects on firm performance.

A caveat is that the cost perspective of the effects of management practices might be underestimated since management practices need to influence not only the production cost and inefficiency but also service quality, customer satisfaction, and loyalty, and other essential productivity and profitability measures that were not reflected in this article. Also, the return on improved management might not be fully reaped in the short run, as Leung and Law (2013) argue in the case of the return on information technology. The effects of improved management practices can also be revealed in input decisions and in more predictable work situations, which may be a source of employee motivation and increased satisfaction (Milliman et al., 2018). Such measures of firm performance and the impact of improved management practices on them are topics for future research. There are also limitations related to sample units and periods. Despite the sample representativeness regarding the geography and typology of hospitality firms, the data we used in this study came from hotels (and restaurants) that belong to three chains in Norway and use a SaaS software system. But, there are hospitality firms in Norway that are members of other chains or those that are engaged in a franchise or independent operations. Also, the data period is a little bit old and covers only four years. Thus, future research should extend the investigations to the diverse groups of hospitality firms and implement the estimations on more recent data.

Note

1. The reasons for Norway to recover from the impacts of this crisis in a very short period can be found in this article. https://rethinkeconomics.no/2018/10/24/the-financial-crisis-and-Norway/

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Appendix

Table A1. Estimation results from the maximum likelihood of stochastic frontier analysis.

IDF	(1)	(2)	(3)
Constant	5.719***	5.877***	−0.037**
	(0.1560)	(0.0960)	(0.0184)
$\ln \tilde{x}_{2it}$	−0.658***	0.661***	−0.655***
	(0.0185)	(0.0154)	(0.0185)
$(\ln \tilde{x}_{2it})^2$	−0.071***	−0.072***	−0.071***
	(0.0021)	(0.00212)	(0.0021)
$\ln y_{1it}$	−0.080***	−0.146***	−0.079***
	(0.0158)	(0.0108)	(0.0159)
$\ln y_{2it}$	−0.331***	−0.499***	−0.335***
	(0.0204)	(0.0157)	(0.0203)
$\ln y_{3it}$	−0.095***	0.104***	−0.100***
	(0.0214)	(0.0162)	(0.0215)
$(lny_{1it})^2$	0.024***	0.023***	0.023***
	(0.0014)	(0.0014)	(0.0014)
$(\ln y_{2it})^2$	0.068***	0.070***	0.069***
	(0.0015)	(0.0015)	(0.00149)
$(\ln y_{3it})^2$	−0.017***	−0.017***	−0.017***
	(0.0017)	(0.0017)	(0.00171)
$\ln \tilde{x}_{2it} \ln y_{1it}$	−0.022***	−0.023***	−0.022***
	(0.0019)	(0.0019)	(0.0019)
$\ln \tilde{x}_{2it} \ln y_{2it}$	0.031***	0.034***	0.031***
	(0.0015)	(0.0015)	(0.00154)
$\ln \tilde{x}_{2it} \ln y_{3it}$	0.038***	0.038***	0.038***
	(0.0021)	(0.0021)	(0.0021)
M_{it}	−0.034*		−0.037**
	(0.0183)		(0.0184)
$(M_{it})^2$	0.011***		0.011***
	(0.0014)		(0.0014)
$M_{it} \ln \tilde{x}_{2it}$	0.0031**		0.003**
	(0.0014)		(0.0014)
$M_{it} \ln y_{1it}$	−0.0099***		−0.0098***
	(0.0018)		(0.0018)
$M_{it} \ln y_{2it}$	−0.020***		−0.020***
	(0.0015)		(0.0015)
$M_{it} \ln y_{3it}$	0.027***		0.028***
	(0.0020)		(0.0020)
$\tilde{t}$	0.094***	0.064***	0.092***
	(0.0235)	(0.0209)	(0.0235)
t^2	0.0009	0.0007	0.0010
	(0.0023)	(0.0023)	(0.0023)
$\ln \tilde{x}_{2it} t$	−0.010***	−0.009***	−0.010***
	(0.0018)	(0.0018)	(0.0018)
$\ln y_{1it} t$	0.006***	0.002	0.007***
	(0.0023)	(0.0022)	(0.0023)

(*Continued*)

Table A1. Continued.

IDF	(1)	(2)	(3)
$\ln y_{2it}t$	-0.005^{***}	-0.006^{***}	-0.005^{**}
	(0.0019)	(0.0019)	(0.0019)
$\ln y_{3it}t$	0.0009	0.0007	0.0010
	(0.0023)	(0.0023)	(0.0023)
$M_{it}t$	-0.010^{***}	-0.009^{***}	-0.010^{***}
	(0.0018)	(0.0018)	(0.0018)
2.*Chain*	0.006^{***}	0.002	0.007^{***}
	(0.0023)	(0.0022)	(0.0023)
3.*Chain*	-0.005^{***}	-0.006^{***}	-0.005^{**}
	(0.0019)	(0.0019)	(0.0019)
σ_u			
Constant	-0.008^{***}	-0.001	-0.008^{***}
	(0.0026)	(0.0025)	(0.0026)
M_{it}	-0.003^{**}		-0.003^{**}
	(0.0015)		(0.0015)
2.*Chain*	0.222^{***}	0.223^{***}	0.223^{***}
	(0.0037)	(0.0037)	(0.0038)
3.*Chain*	-0.178^{***}	-0.176^{***}	-0.179^{***}
	(0.0074)	(0.0071)	(0.0074)