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Instant Messaging and Employee's Performance: A Text Mining Approach

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Completed Research

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Abstract

The adoption of Instant Messaging (IM) applications in the workplace remains contentious due to difficulties in adequately quantifying organizational benefits and how it affects individual performance. Previous research on the impact of IM usage on employee performance has been limited to analyzing primary data (i.e., survey methods), making it difficult to extrapolate the findings to a constantly changing workplace. In contrast, we investigate the relationships between these individuals' IM usage at the workplace and their primary assessment metric in their organization, performance evaluation, using longitudinal data of employees' IM activities and their performance evaluation collected from a US Fortune 500 financial company. Using cutting-edge text-mining techniques, we identify the primary purposes of IM utilization in organizations and assess the impact of those attributes on employee performance. Our findings show that IM in the workplace can improve team communication, knowledge-sharing experience, and social networking among employees, but it can also be disruptive. However, the combined effect of team communication and knowledge sharing on employee performance can overshadow the negative impact of IM interruption on employee performance.

Keywords: Instant Messaging, Employee's Performance, Text-Mining, Machine Learning, IT Technology Adoption

Introduction

Instant messaging applications have grown in popularity over the last decade, and businesses are increasingly interested in implementing them within their organizations (C Riedl 2020). Individuals can communicate in real-time using IM technologies, and their casual and simple nature makes social interaction easier. Furthermore, when compared to other communication media, IM facilitates knowledge-sharing activities by making information more instant, accessible, trustworthy, consistent, and accurate. In contrast to the growing popularity of these applications as a form of informal employee communication, IM adoption in the workplace has been contentious. The complexity involved in measuring the organizational benefits or potential harms of IM usage on employee performance is one of the most significant factors contributing to this quandary.

On the other hand, the effects of IM use on employee performance have not been thoroughly investigated and have never been measured using methods other than surveys or experimental designs. Furthermore, the failure to address the concerns raised by these research methodologies (survey and experimental procedures) resulted in some contradictory findings, undermining the case for generalizability. This is the

first study to identify where and how IM is used by employees in today's workplace and measure the impact of those attributes on employee performance by identifying a novel set of constructs using text-mining techniques on IM data collected from a large financial corporation.

Prior research identified work interruption as a significant barrier to IM adoption in the workplace. Some authors, for example, proposed that IM use in the workplace increases work interruption, and that related distractions can harm employee performance and overall organizational performance (Addas and Pinsonneault 2018; Garrett and Danziger 2007; McFarlane and Latorella 2002; O'Conaill and Frohlich 1995; Ou and Davison 2010; Rennecker and Godwin 2005). Others have even suggested that interruptions from IM applications may increase employees' perceptions of mental overload (Gupta et al. 2013; Li et al. 2011). The authors proposed that cognitive overload, compared to other communication methods such as email, can cause time pressure and reduce overall employee performance.

Other scholars (Gao et al. 2019; Ou and Davison 2016; Rajaee Harandi and Abdolvand 2018; Rodrguez-Aceves et al. 2018) examined the role of IM in enhancing social networking experience and network ties among employees and proposed how these can improve employee productivity because of the interactive and social networking nature of IM. As an example of CMC technology, IM has revolutionized workplace interaction and facilitated organizational communication and knowledge sharing among employees, which was previously impossible (C Riedl 2020). Researchers proposed that using IM improves communication quality within the organization and increases employee trust (Ou and Davison 2010; Ou et al. 2010; Ou et al. 2011). The authors also discussed how these mediating variables will improve overall group outcomes and employee performance. Other researchers (Gao et al. 2019; Mansi and Levy 2013; Ou et al. 2010; Ou et al. 2011; Quan-Haase et al. 2005) have proposed that IM usage at the workplace positively influences knowledge-sharing experience among employees and can increase the quality of information (knowledge) shared between colleagues who believe the information is more accessible and trustworthy this way.

This paper proceeds as follows. In the next section, we introduce the literature on IM usage contexts at the workplace and explain their impact on employee performance. We then describe the research methodology to clarify the data collection process and Multi-label IM classification. Then analyses are performed, and then results and conclusions are discussed. In conclusion, we discuss limitations and future research possibilities.

Literature Review

Instant Messaging (IM) applications, also known as workplace chatting, are rapidly gaining traction in the workplace (C Riedl 2020; Finly 2017). Compared to other communication channels (email, phone, etc.), IM allows employees to communicate more seamlessly and quickly, and it can improve mobility and accessibility within an organization. When it was first introduced as a collaborative and informal mode of communication, IM's adoption in the workplace was contentious. Researchers are still debating the benefits and drawbacks of IM use on employee performance. Their findings sometimes contradicted each other, making it nearly impossible to draw any causal conclusions or generalize the findings.

One of the primary reasons for this quandary is the researchers' methodologies. For example, Garrett and Danziger (2007) conducted a survey analysis and found that IM usage in the workplace has no effect on team communication. In contrast, Qu et al. (Ou et al. 2010; Ou et al. 2011) investigated the role of IM usage on employees using the same research methodology (survey), and their findings suggested that IM usage is positively associated with team communication. Furthermore, another concern in the context of IM research is the difficulties in identifying and quantifying the benefits and harms of IM usage on employee performance. At the same time, the majority of the literature in this domain has relied on survey or experimental methods to examine IM characteristics and usage purposes. We contend that several concerns about such methods jeopardized their reliability (particularly in the context of IM research), resulted in contradictory results in the literature and made any causal implication nearly impossible.

Researchers may find survey methods easier to administer in terms of time (shorter time compared to other approaches), location (reachability without any geographical dependency), and pool size (collect data from a large number of respondents). However, such survey analysis contains a few significant issues. First, employees may not feel comfortable sharing precise, correct survey responses for various

reasons. For example, survey participants may not feel encouraged to share an opinion that may place them in awkward situations. Even if respondents provide accurate answers on the purposes of IM use in the workplace, they may overestimate (or even underestimate) their performance when asked to measure one.

Furthermore, for a variety of reasons, participants may not be fully aware of the basis for any shared response (e.g., fatigue or bad memory). How, for example, can one determine how much of his IM time is spent on knowledge-sharing activities versus social networking? Besides this, survey question answer options may result in ambiguous data because respondents may interpret specific answer options differently. For example, the answer option "I somewhat agree that IM is interruptive" may refer to different topics and have a different meaning for each participant. Furthermore, using survey methods to quantify the variable of interest can sometimes be challenging. For example, measuring and validating employee performance based on survey questionnaire results is difficult, especially if the results are based on qualitative statements.

Concerns about experimental methods are similar. Human error in design, implementation and measurement frequently impacts experimental research methodology findings. Furthermore, experimental research can create unrealistic situations, particularly in the domain of IM research; it is difficult to imagine that researchers can provide a setting in which they can measure the application of IM and then assess employee performance based on that. Furthermore, if carefully carried out, experimental research can estimate the significance of answering Yes or No to a specific question while falling short of providing an actual explanation. One example from the IM literature is IM interruption, in which participants are given a task and then interrupted by an IM message during the experiment; researchers then assess the quality of tasks performed by individuals before and after the interruption. Researchers could say whether or not IM is disruptive, but they could not say how or why it affects performance positively or negatively.

Although many studies have looked at issues such as IM adoption in the workplace, there is a lack of empirical research investigating both the positive and negative impact of IM usage on employee performance. The existing gap in the literature unlocked the way to solve the problem through a different lens. Text-mining and machine learning techniques that are currently available can enable researchers to mine the corpus of IM conversations and discover valuable insights for future prediction and decision-making processes. We have a solid opportunity to identify how IM is currently being used in the workplace and how these applications can empower or lower employee performance by applying text-mining techniques to the unique dataset collected from an S&P 500 company. Table 1 contains definitions of principal constructs as well as a representation of the entire set of hypotheses. Although many studies have looked at issues such as IM adoption in the workplace, there is a lack of empirical research that investigates both the positive and negative impact of IM usage on employee performance. The existing gap in the literature opened the door to solving the problem through a different lens. Text-mining and machine learning techniques that are currently available can enable researchers to mine the corpus of IM conversations and discover valuable insights for future prediction and decision-making processes. We have a solid opportunity to identify how IM is currently being used in the workplace and how these usage applications can empower or lower employee performance by applying text-mining techniques to the unique dataset collected from an S&P 500 company. Table 1 contains definitions of principal constructs as well as a representation of the entire set of hypotheses.

Construct	**Description**	**References**	**Methodology and Sample Size**	**Horizon**
IM Usage at Workplace (IM)	The employee's use of IM for work-related activities like routine communication, answering questions, and engaging in work-related socialization	Cho et al. 2005	Survey (137), interview (13)	Examined how IM can help employees improve their work relationships within and outside the organization.
		De Vos et al. 2004	Survey (102), interview (104)	Investigated the adoption of IM technology before and after it was formally introduced in an organization

		Ou and Davison 2010	Survey (253)	Investigating if IM usage can result in work disturbance and improved communication quality
		Zhang and Venkatesh 2013	Survey (104)	Identified how online and offline communication tools could impact employee performance in the workplace
Social Networking (SN)	IM activities involve social contacts, relationships, network ties, and associations by making connections through individuals.	Cetinkaya and Rashid 2018	Survey (205)	How does the social networking application usage correlate with job performance at the workplace, and whether the corporate structure has any mediating effect or not
		Cho et al. 2005	Survey (192)	How IM can help employees of an organization improve their social relationships
		Chow and Chan 2008	Survey (190)	Developing an understanding of social ties in organizational knowledge-sharing.
		Park et al. 2017	Survey (141)	Investigating the impact of social networks on work performance by focusing on knowledge excellence and variety based on social networking theory and the knowledge-based view
Team Communication (TC)	IM activities involve routine interactions and communications among employees		Survey (90)	This study analyzed how communication platforms can enhance team working in collaboration
		Maina 2013	N/A	How IM helps with effective team communication and boost multi-tasking.
		(Abudaqa et al. 2019)	Survey (134)	The study examined the role IM in increasing team communication among workers.
		Ou et al. 2010	Survey (253)	How IM technologies can notably enhance communication performance inside organizations
		Zhang and Venkatesh 2013	Survey (104)	Examined the role of online and offline workplace communication platforms on employee team communication.
		Zhang et al. 2012	Interview (16)	Impact of IM on communication and knowledge visibility.
Knowledge Sharing (KS)	IM activities involve any type of knowledge transfer from one employee to another, which can be tacit (undocumented) and explicit (documented).	Ou et al. 2014	Survey (41)	Investing in how IM directly affects knowledge generation and whether IM use is correlated with knowledge generation
		Davison et al. 2013	Interview (100)	Explored the role of interactive communication tools in knowledge sharing.
		Zhang et al. 2012)	Interview (16)	Impact of IM on knowledge visibility
		(Bidian and Evans 2018)	Survey (126)	Examined the technology preferences in the role of organizational knowledge-sharing

				activities
Work Interruption (WI)	IM activities that the recipient does not initiate and are unscheduled result in the recipient discontinuing their current work activity.	(Maçada et al. 2022)	Survey (399)	Examined the effects of the interruptions caused by communication technologies on the employees' performance
		Chen and Karahanna 2018	Interview (16)	Examined the effects of the interruptions caused by communication technologies on the outcome of work and non-work activities
		Garrett and Danziger 2007	Survey (912)	Investigating how ease of use of Instant Messaging (IM) leads to an increase in task interruption
		Mark et al. 2005	Experiment (24)	Examining the nature of fragmented work and the role of computer-mediated application and technology-rich tools
		Ou and Davison 2010	Survey (253)	Investigating if IM usage can result in work disturbance
		Rennecker and Godwin 2003	N/A	Arguing that IM usage will increase the likelihood of productivity decline due to increased workloads caused by IM usage and interruptions.
Employee's Performance (EP)	Employees' performance can be defined as the ability of employees to accomplish their mission based on the expectations of an organization	(Orhan et al. 2021)	Survey (369)	The authors examined the concern of technology interruption in the workplace and proposed that such communication positively influences employee performance and negatively impacts work engagement.
		Fuller et al. 2006	Field study (318)	Evaluated the team and individual performance under a virtual collaborative environment
		Ou and Davison 2010	Survey (253)	Examined the role IM usage on individual and group outcomes by focusing on quality and trust factors in communication platforms.
		Ou et al. 2011	Survey (43)	Evaluating the impact of IM usage facilitating knowledge-sharing activities at work and how those impact employee and work performance.
		Rajaee Harandi and Abdolvand 2018	Field study (50)	Investigating the role of IT decisions on employee performance

Table 1. Constructs and principal definition

IM Usage and Team Communication

Communication is a significant element in every organization (Kristina 2020; Rajhans 2012). Establishing a collaborative environment among workers is crucial, allowing the organization to function more

effectively. As a collaborative tool, IM currently significantly influences how employees communicate with each other. While companies try to develop and implement new workplace communication approaches, it is vital to understand that multi-purpose tools like IM have become powerful tools for organizing communication, specifically during extreme situations where face-to-face communication is impossible (like COVID-19). IM technologies are proven to improve communication in the workplace, and with its ease of use and efficiency, it encourages the employee to use it as a platform that allows messages to appear immediately, like a near-synchronous and lifelike communication channel. Using IM, employees can build and maintain relationships if problems arise that require assistance.

IM application is an easy tool that encourages employee communication, helps share ideas, and increases engagement (Korzynski 2015; Ou and Davison 2010; Rajhans 2012). Given the growing adoption of interactive communication tools like IM at the workplace, understanding the elements that influence team communication and performance has become increasingly important. Literature has examined various communication performance metrics and the underlying element in the context of virtual communication environments. Fuller et al. (2006) proposed that team communication and communication performance include the employee's perception of communication and professional interaction to be "timely, adequate, accurate, complete, interactive, and effective".

Qu et al. (Ou and Davison 2010; Ou et al. 2010) also proposed that if organizations consider communication tools like IM as an integral component of their larger corporate technology culture, they can create an environment where employees can enhance their communication and collaboration skills. Moreover, employees can augment the quality of organizational decisions and task outcomes and ultimately improve employee and organizational performance. Employee's performance can be defined as an individual's ability to perform their job effectively. An employee who achieved his goals or accomplished his tasks feels more confident talking to other colleagues and getting assistance or advice regarding professional evolution. In an organization that adopted IM technology, IM allows the employees to communicate with other colleagues in real-time, with no delays such as those associated with tools like email communication.

In such organizations, IM can promote itself as an environment that can improve routine communication, interactivity, and approachability. Over these communication and collaboration practices in the IM environment, employees, managers, and other stakeholders can consistently reinforce the company goals and directives and enhance productivity. Therefore, we form the following hypotheses:

Hypothesis 1a: *IM usage at the workplace is positively associated with team communication.*

Hypothesis 1b: *Team communication is positively associated with employee performance.*

IM Usage and Knowledge Sharing

As IM tends to complement other communication tools that require a more formal procedure, it can be a good fit that enhances the knowledge-sharing experience between employees(Bakar and Johari 2009; Davison et al. 2013; Kotlarsky and Oshri 2005; Ou et al. 2014; Zhang et al. 2012). The primary goal of knowledge sharing (KS) in organizations is to avoid repetitive mistakes by adopting and applying previously acquired knowledge(Hanisch et al. 2009). Metzger and Flanagin (2013) proposed that employees believe the information is more accessible, trustable, consistent, and accurate in the organization that adopted IM technology. Organizations have been taking steps to mitigate knowledge loss by investing in technologies like Instant Messaging applications that help facilitate knowledge transfer within the organization. Effective and practical knowledge-sharing experiences among employees are crucial for achieving and sustaining a competitive advantage for any organization (Buckley and Carter 2000). As Ahmad and Karim (2019) suggested, successful knowledge sharing is associated with higher employee creativity, productivity, and prolonged organizational survival.

IM allows work professionals to connect with one another and can facilitate instant communication via the pop-up dialogue box feature. By connecting employees, IM platforms enable employees with a valuable avenue to share, transfer, document, information, and knowledge. In other words, IM technologies' characteristics boost successful knowledge-sharing experiences among employees (Argote & Ingram, 2000), and its informal characteristics make it easier for employees to engage in more knowledge-sharing activities. In their study, Srivastava et al. (2006) delivered empirical corroboration

that knowledge sharing is positively associated with employee performance. More knowledge-sharing activities between employees bring new and innovative ideas to the organization, which may help the organization solve complex problems more effectively. Stasser and Titus (1985) posited that accomplishing a task, especially in a domain where teamwork and collaboration are a must, depends on various supporting factors, including methods, procedures, processes involved, groundbreaking initiatives, and mental models. Not equally, but all of these factors can enhance knowledge-sharing experiences among team members.

However, literature proposed that when knowledge drastically pours into the organization, the ability to conquer complex problems will be elevated excessively in more efficient ways (Soo et al., 2002), which can positively impact the employees' performance in the workplace. As a result, individual and group performance will be impacted by those employees who are capable and inclined to apply new knowledge in making decisions. Taking all these arguments together, we suggest:

Hypothesis 2a: *IM usage at the workplace is positively associated with Knowledge Sharing*.

Hypothesis 2b: *Knowledge Sharing is positively associated with employee performance.*

IM Usage and Social Networking

Instant Messaging technologies, by nature, are social networking platforms that allow employees to communicate and connect for accessible communication. As explained in the literature, IM is a potent communication tool generally adopted in the social networking context, which can empower employees' social relationships and enhance network ties.

Due to the features available in IM technologies, these applications can reshape mutual and instant communication, reminding users of the openness and transparency they witnessed only in face-to-face communication. Such communication can benefit organizations with distributed or remote employees across the globe without geographical and temporal dependencies. In places where IM technologies are well adopted, building and maintaining social relationships no longer depend on physical communication but on online and instant communications.

In an organizational environment where IM technology is adequately adopted, employees can nurture a balanced environment for collaborative work (Chow and Chan 2008). Once socially networked, the higher the network's density, the better the task performance (Ramasamy 2006). Hence, employees often work together to develop a robust social tie because of bilateral understanding. As a social networking tool, IM provides an environment that facilitates such behaviors (Cho et al. 2005). Acting as a social networking platform, representing informal communication, and promoting approaching colleagues, IM can give employees the needed breaks when the workplace becomes an intensive work setting and can even offer ways to distinguish colleagues' successes and allow individuals to connect professionally and socially.

Social networking is critical for both individual and team performance in any organization. With the growing number of communication tools organizations use, it is vital to identify the elements that impact employee performance. Researchers (e.g., Fuller et al., 2006) have examined various employee performance metrics and the impacting elements in the virtual workplace context. Ou et al. (2014) proposed that socially connected employees can benefit from a harmonious environment that encourages collaboration. Notably, social networking can catalyze knowledge sharing and teamwork experience, allowing individuals to accomplish bigger tasks and reach higher outcomes by elevating individual and group satisfaction. Therefore, the tie among employees in a network can elevate cooperation, enhancing individual and team performance (Molm, 1994). As Sparrowe et al. (2001) stated:"The higher the density of a network, the better the performance that can be achieved".

In their study, Cetinkaya and Rashid (2018) proposed that social networking activities at the workplace positively correlate with employees' job performance by applying a structural equation modeling technique to survey data. Park et al. (2017) proposed that employees get involved in social networking activities to help themselves solve problems and enhance performance. The authors believed that employees could engage in different social interactions to improve their knowledge base through weak and strong ties. These social network activities significantly impact both creativity and productivity of job performance in the workplace. Hence, we hypothesize that:

Hypothesis 3a: *IM usage at the workplace positively impacts employees' social networking*.

Hypothesis 3b: *Social Networking is positively associated with employee performance.*

IM Usage and Work Interruption

Work Interruption is one of the significant concerns that exist in today's organizations. The problem is noted to be the worst, especially for organizations with widely applied computer-mediated technologies.

Moreover, according to the literature (Garrett and Danziger 2007; Rennecker and Godwin 2003), IM users may experience a higher interruption rate than non-IM users. The experience comes from the characteristics embedded in any IM platform these days, including presence awareness, pop-up notification, and polychronic communication (Rennecker and Godwin 2003). Even though the current IM applications provide options (for example, changing your status to "Busy") to control the number of interruption incidents, the authors believe that IM applications' characteristics expand employees' reachability beyond time and geographical space for more interruptive interplay.

One of the primary concerns of high interruptions may relate to its impact on employee productivity. Mark et al. (2005) proposed that, on average, employees need at least 11 minutes to reach the same point on an interrupted job. Authors projected that the most significant chunks of the interruptions are usually not related to the ongoing task, which may unwillingly drag employees into subjects demanding more time and attention. Repeated occurrence of such interruptions has proven to be distractive and obstructive to employees and will significantly negatively impact their performance.

In a nutshell, the interruption can be considered specific events that interfere with the ongoing tasks and processes that result in the cessation and suspension of work activity, negatively impacting the employee's performance. Interruptions make employees take longer to complete a task, degrade the overall quality of the task, and ultimately lower employee productivity. Thus, to end this section, we form our hypotheses as follows:

Hypothesis 4a: *IM usage at work will increase work Interruption.*

Hypothesis 4b: *Work Interruption is negatively associated with Employee Performance.*

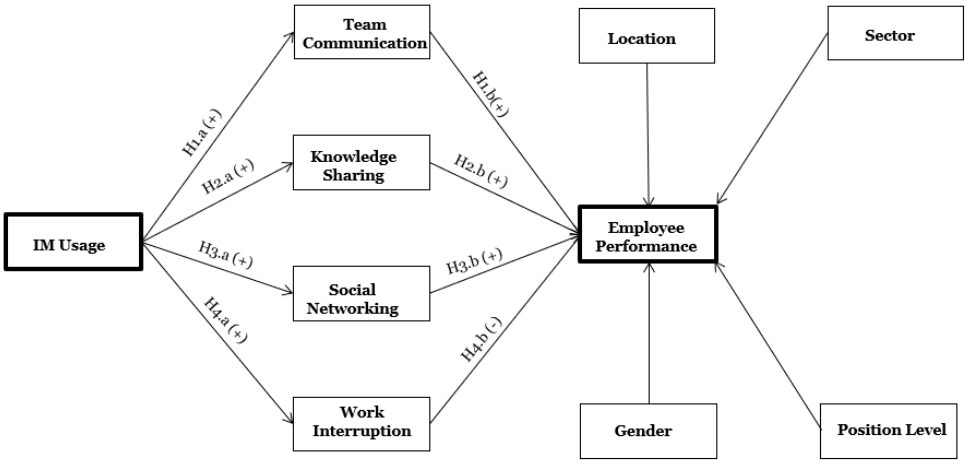

Figure 1. Research Model

Methodology

Data Collection

We collected a unique dataset that includes IM conversations for 136 professional working staff from a large US Fortune 500 financial company where IM technology (tool) has been implemented and adopted for more than ten years within the organization. The dataset obtains 216,147 conversations between these

employees from October 2017 to September 2018 (one full fiscal year). Besides, we collected monthly performance evaluation scores of these 136 employees for the same period (one full fiscal year). In the next section, first, we apply supervised machine techniques to the body of content of these IM conversations to label all IM conversations and identify each IM conversation's usage purposes.

Multi-label IM classification

Multi-label text classification has many real-world applications, such as classifying businesses on Yelp or categorizing movies into one or more genres. We applied Multi-label Classification techniques (Read et al. 2009) to assign each IM conversation a set of target labels like *knowledge sharing*, *team communication*, *social networking*, and *interruption*. The framework can be explained as predicting properties of a data point that are not mutually exclusive, i.e., an IM conversation can be categorized as social networking, team communication, and even interruption. We randomly selected and then hand-coded 7,500 conversations out of the entire set of conversations to create the main training set. We coded each conversation to measure the effect of social networking, knowledge sharing, team communication, and work interruption on employee performance. Detailed coding schemes for independent variables are attached in Appendix A.

In the next step, we retrieved the textual data and transformed it into a consistent form for the multiple state-of-the-art classifiers we wanted to use. For that, the standard NLP data preparation techniques (Kowsari et al. 2019) have been applied on top of other ad-hoc text processing and transformations for this dataset's specific nature. We removed the parts of the text repeated in every chat and then applied automatic translation, ensuring the whole corpus transformed into a single language, English, in this case. We also removed incomplete and meaningless conversations. Then, we preprocessed the texts using tokenization, lemmatization, stop-words, and digit removal and added n-grams to the dataset to guide the classification models (Kowsari et al. 2019). The idea here is to treat short sequences of words as single entities or tokens containing helpful information for the classification part. Then, we trained a few state-of-the-art classifiers, including tree-based classification models such as Random Forest, Probabilistic classification models such as Naive Bayes, Geometric classification models such as Logistic Regression and Support Vector Machine (SVM), and Artificial Neural Network (ANN). Each algorithm was implemented in Python using Scikit-learn, a free Python software learning library. Consistent with text-mining principles (Ian and Eibe 2005), each algorithm (classifier) was assessed with precision, recall, and f-measure. The formula for each metric is described below:

$$Precision(i) = \frac{\text{Number of correctly classified IMs for class } i}{\text{Total number of IMs identified as class } i}$$

$$\text{Recall}(i) = \frac{\text{Number of correctly classified IMs for class}}{\text{Total number of IMs in class } i}$$

$$\text{F} - \text{measure}(i) = \frac{2 * \text{precision}(i) * \text{recall}(i)}{\text{precision}(i) + \text{recall}(i)}$$

To select the optimal and final classifier, we pick the model with the highest f-measure. It is worth noting that the methodology adopted for each section of the text mining approach, including training, evaluation, and algorithm selection, is widely accepted in the data-mining literature (Ian and Eibe 2005).

Classification results

Comparing all classifiers' evaluation metrics, random forest achieved the highest f-measure (91.6 percent on average for all desired categories, please see Table 2). Random forest classified 72.2% of IMs as regular team communication between employees. It also identified 31.6% of IMs as conversations that are used for knowledge-sharing purposes. About 3.2% of employees' conversations were used for social networking matters, and almost 3% were interruptive. Initial findings over IM usage purposes at workplace bold the importance of such technology and its impact on employees' daily communication and knowledge-sharing activities. Using the classified dataset from the above process, we formed a panel dataset for all employees (from October 2017 to September 2018). Every row in the dataset includes the monthly count of IM messages for different categories of interest for each user. In each row, employees' monthly performance

evaluation is also included. A monthly performance evaluation is a score given by upper-level management that demonstrates how effectively an employee achieves assigned project key objectives and tasks every month (The score ranged from 0 to 4 where 4 is considered the highest value an employee can earn).

Model	Precision				Recall				F-Measure			
	TC	KS	SN	WI	TC	KS	SN	WI	TC	KS	SN	WI
RF	94.6%	93.2%	90.6%	88.8%	93.8%	93.1%	90.6%	88.6%	94.2%	93.1%	90.6%	88.7%
ANN	92.2%	91.4%	90.1%	86.7%	92.1%	91.3%	90.1%	86.4%	92.1%	91.3%	90.1%	86.5%
SVM	92.1%	91.2%	89.4%	86.4%	92.1%	89.2%	89.4%	86.1%	92.1%	90.1%	89.4%	86.2%
NB	87.8%	87.1%	82.2%	79.6%	86.2%	85.1%	79.2%	78.6%	86.9%	86.1%	80.6%	79.1%
LR	90.2%	89.9%	86.5%	83.2%	90.1%	88.6%	85.5%	83.1%	90.1%	89.2%	86.0%	83.1%

IM: IM Usage, SN: Social Networking, TC: Team Communication, KS: Knowledge Sharing, WI: Work Interruption, EP: Employee's Performance, RF: Random Forest, ANN: Artificial Neural network, SVM: Supported Vector Machine, NB: Naïve Bayes, LR: Logistic Regression.

Table 2. Classification results

Variables

In our analysis, the primary dependent variable is *employee performance*. An employee performance evaluation, also known as a performance review, is a process facilitated by organizations giving employees feedback on their job performance and formally documenting that performance. In our case, the score ranged from 0 to 4, where 4 was considered as the highest value an employee can earn. The employee performance variable is denoted by $employee\ performance_{it}$, which declares the score a member i made at the time (month) t. Next, we introduce the independent variables and provide a detailed procedure to obtain information about them. The first independent variable is knowledge sharing, and we define $knowldge\ sharing_{it}$ as the number of IM conversations user i used at month t for to gain or transfer knowledge. Another independent variable is team communication, calculated based on the number of IM conversations one used to communicate with other colleagues. Let $team\ communication_{it}$ be the number of IM conversations user i used at month t for communication purposes. For social networking type of IM messages, we define $socail\ networking_{it}$ as the number of IM conversations user i used at month t for social networking activities. We also calculated monthly IM conversations that were interruptive for each user and formed an independent variable $work\ interruption_{it}$. Moreover, we included four control variables in our model available in the dataset: Gender, Location (States at four levels), Position Level (at four levels: SVP, VP, AVP, Analyst), and Sectors (at eight levels: Consumer, Audit, Finance, Compliance, Technology, Client, HR, and Risk). Our research methodology is presented in Figure 2.

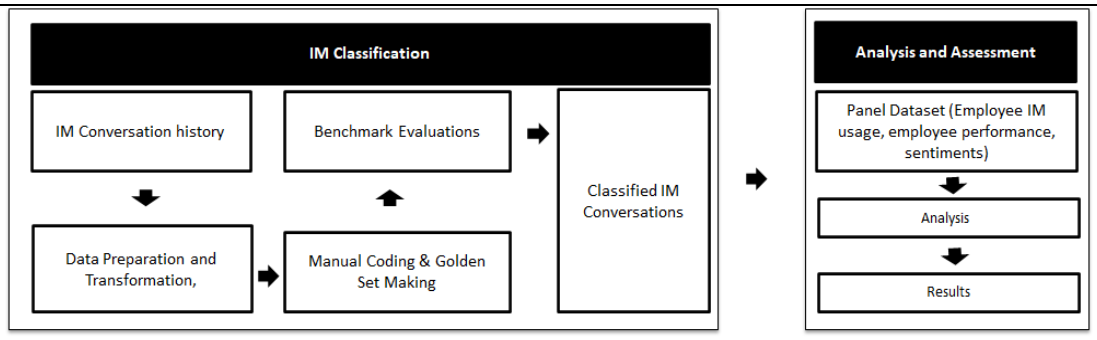

Figure 2. Research Methodology

	Mean	STD	Max	Min	1	2	3	4	5	6
1- Total IM	160.867	43.050	251	67	1.000	-	-	-	-	-
2- Team Communication	116.064	33.221	203	45	0.091	1.000	-	-	-	-
3- Knowledge Sharing	36.117	11.796	73	10	0.077	0.074	1.000	-	-	-
4- Social Networking	13.764	4.995	30	4	-0.071	0.068	-0.058	1.000	-	-
5- Work Interruptive	5.583	2.828	15	1	-0.050	0.046	0.041	0.038	1.000	-
6- Performance	3.174	0.379	4	2.200	0.053	0.048	-0.042	0.040	0.029	1.000

Table 3. Descriptive Statistics

Based on the above procedure, we gathered relevant measures for these variables. Table 3 shows descriptive statistics and correlation analysis results for panel data of 136 employees from October 2017 to September 2018. According to the Pearson correlation analysis, three statistically significant positive correlations exist. As presented in Table 3, there is no significant correlation between variables.

Model Specification

We specified a few linear regression models to estimate the relationship between employee performance and IM usage purposes (social networking, team communication, knowledge sharing, and interruption) at the workplace. Our first model, the fixed-effects (F.E.) model accounts for the repeated-measurement nature of the data (i.e., each employee used IM for several purposes) by allowing each employee to have their own intercept in the model. As such, the model accounts for unobserved heterogeneity in addition to observed heterogeneity. The model is shown below:

$$\begin{aligned} &employee\ pormance_{it} \\ &\quad = \alpha_0 + \alpha_1 social\ networking_{it} + \alpha_3 team\ communication_{it} \\ &\quad + \alpha_4 \text{knowledge sharing}_{it} + \alpha_4 \text{work interruption}_{it} + \mu_i + \varepsilon_{it} \end{aligned} \quad (1)$$

where μ_i represents individual fixed effects and ε_{it} is idiosyncratic error terms. ε_{it} is different for each individual employee at each point in time. However, μ_i only changes across individual employees but not across time. μ_i is representing the effects of all the time-invariant variables that have not been included in the model. Moreover, as we can control for heterogeneity, this model allows heterogeneity to exist within the model. However, if the unobserved variables across individual employees are random, estimates from the random-effects model are consistent. Random effects (R.E.) models can regulate the effects of unobserved variables as random variables over time, which can switch between fixed effects and the Ordinary Least Squared model. It means the model can concentrate on both dependencies between and within individuals. Thus, our second specification is a random-effects model:

$$\begin{aligned} &employee\ pormance_{it} \\ &\quad = \alpha_0 + \alpha_1 social\ networking_{it} + \alpha_3 team\ communication_{it} \\ &\quad + \alpha_4 \text{knowledge sharing}_{it} + \alpha_4 \text{work interruption}_{it} + \gamma \mathrm{Z}_i + \mu_i + \varepsilon_{it} \end{aligned} \quad (2)$$

where Z_i depicts a set of time-invariant control variables (such as gender and location), μ_i is individual random effects and ε_{it} is the idiosyncratic error term. We also apply a pooled regression (I.e., Pool Effects, P.E.) model to compare the results, which can be considered a simple Ordinary Least Squared (OLS) model applied to the panel dataset, without taking any time and individual characteristics into account and focusing only on dependencies between the subjects.

$$\begin{aligned} &employee\ pormance_{it} \\ &\quad = \alpha_1 social\ networking_{it} + \alpha_3 team\ communication_{it} + \alpha_4 \text{knowledge sharing}_{it} \\ &\quad + \alpha_4 \text{work interruption}_{it} + \gamma \mathrm{Z}_i + \mu_i + \varepsilon_{it} \end{aligned} \quad (3)$$

Moreover, we also form separate linear regression models to measure the effect of instant messaging usage at the workplace on team communication, knowledge sharing, social networking, and work interruption (please see Appendix).

Results

The model results indicate a significantly positive coefficient for team communication ($\beta = .242$, $p < .01$), consistent with H1.b (team communication is positively associated with employee's performance). Further, compatibly with H2.b, the coefficient of knowledge sharing is significantly positive ($\beta = .067$, $p < .01$) (indicating that higher knowledge sharing is correlated with higher ratings of employee performance). However, different from our expectations, we could not find the effects of social networking on employee performance. Therefore, H3.b is not supported. According to the results and consistent with H4.b, the coefficient of the work interruption is moderately significant and negative ($\beta = -0.405$, $p < .1$ for the fixed-effects model and $\beta = -0.437$, $p < .05$ for the random-effects model), which indicates that work interruption is correlated with lower ratings of employee performance. As shown in Table 4, these results are highly robust concerning alternative model specifications (i.e., random effects vs. fixed effects vs. pooled regression models). We also performed the Hausman test to check which model is more efficient. In the Hausman test, the null hypothesis will be considered as the preferred model,

random effects, and the alternate hypothesis will be the fixed effects. According to the result ($\chi 2 = 1.5$, $p < .82$) preferred hypothesis, which is the random-effects model, is efficient.

Variables	**F.E. model**	**R.E. model**	**P.E. model**
Team Communication	0.242***	0.247***	0.247***
	(0.009)	(0.009)	(0.009)
Knowledge Sharing	0.067***	0.075***	0.075***
	(0.024)	(0.024)	(0.024)
Social Networking	0.017	0.013	0.013
	(0.061)	(0.059)	(0.059)
Work Interruption	-0.405*	-0.437*	-0.437*
	(0.247)	(0.241)	(0.241)
Gender (male)	-	0.302	0.302
	-	(1.205)	(1.205)
Location (NY)	-	-0.720	-0.720
	-	(1.434)	(1.434)
Location (PA)	-	0.440	0.440
	-	(1.150)	(1.150)
Location (TX)	-	-0.476	-0.476
	-	(0.968)	(0.968)
Position Level (AVP)	-	1.366	1.366
	-	(0.889)	(0.889)
Position Level (VP)	-	-1.578	-1.578
	-	(1.018)	(1.018)
Position Level (SVP)	-	-1.010	-1.010
	-	(1.369)	(1.369)
Sector (Compliance)	-	-0.562	-0.562
	-	(1.787)	(1.787)
Sector (Consumer)		1.574	1.574
		(1.536)	(1.536)
Sector (Finance)		2.522	2.522
		(1.881)	(1.881)
Sector (HR)		-2.420	-2.420
		(2.713)	(2.713)
Sector (Client)		1.862	1.862
		(1.765)	(1.765)
Sector (Risk)		0.337	0.337
		(2.265)	(2.265)
Sector (Technology)		2.324	2.324
		(1.425)	(1.425)
Constant	-	-2.920	-2.920
	-	(2.553)	(2.553)
R^2	0.404	0.409	0.409
Adjusted R^2	0.349	0.402	0.402
*p<0.1; **p<0.05; ***p<0.01			

Table 4. Regression Results

Variables	**Model (4): the effect of IM usage on team communication**			**Model (5): the effect of IM usage on knowledge sharing**		
	FE model	**RE model**	**PE model**	**FE model**	**RE model**	**PE model**
IM usage	0.637***	0.637***	0.637***	0.209***	0.209***	0.209***
	(0.022)	(0.021)	(0.021)	(0.009)	(0.009)	(0.009)
constant	-	-9.177**	-9.175**	-	-3.524**	-3.524**
	-	(3.567)	(3.567)	-	(1.457)	(1.457)
Observation	1,632	1,632	1,632	1,632	1,632	1,632
R^2	0.368	0.352	0.352	0.270	0.259	0.259
Adjusted R^2	0.310	0.352	0.351	0.204	0.258	0.258
**p<0.05; ***p<0.01						

Table 5. Regression Results

Table 5 and 6 present the results for the models that individually measure the effects of IM usage on team communication, knowledge sharing, social networking, and work interruption. The results indicate a significantly positive coefficient for IM usage (β = .084, p < .01) for the model, which uses team communication as an independent variable (model 2). Consistent with H1.a, results indicate that IM usage at workplace is positively associated with team communication. According to the results, the rest of the models' coefficients are significant. These mean H2.a, H3.a, and H4.a are supported, i.e., IM usage at the workplace is positively correlated with knowledge sharing, social networking, and work interruption.

Variables	Model (6): the effect of IM usage on social networking			Model (7): the effect of IM usage on work interruption		
	FE model	RE model	PE model	FE model	RE model	PE model
IM usage	0.082***	0.081***	0.081***	0.017***	0.017***	0.017***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
constant	-	2.763***	2.765***	-	1.760***	1.761***
	-	(0.539)	(0.539)	-	(0.135)	(0.135)
Observation	1,632	1,632	1,632	1,632	1,632	1,632
R^2	0.296	0.281	0.280	0.221	0.208	0.207
Adjusted R^2	0.232	0.280	0.279	0.150	0.208	0.206
**p<0.05; ***p<0.01						

Table 6. Regression Results

Robustness Analyses

A series of robust tests were performed to address the concerns over the reliability of our findings. First, we ran a few models using alternative samples regarding the IM users to see whether their usage behavior can cause any estimation bias that can impact the ultimate findings. For example, the findings' consistency was tested by running models using sample data that included only substantial members (active users) or less active users. Results from these models confirm that our findings still hold. Second, combining both sent and received IM messages in the sample of analyses might introduce mismeasurement of our variables. We reran our models using alternatives sample that included only sent IM messages or received IM messages. In both cases, we found our results are robust and still hold. Third, having full-time employees (FTE) in the sample used for the analyses might present estimation bias as one might say that these employees may behave differently compared to other types of employees on IM platforms, such as making significant contributions compared to Consultants. We reran the primary models using an alternative sample that excluded all full-time corporate employees (i.e., only full-time consultants remained in the sample). We find our results still hold. Forth, we ran several models by including and excluding the predictors to test the models' (Fixed effects and Random-effects) sensitivity against the variables included in the model. For example, we excluded all the predictors in the first model but knowledge-sharing. We performed similar models by including only one predictor at the time in the model for other independent variables. Further, we ran several models with different combinations of predictors in the models. In all models we ran, we found our primary findings still hold. Fifth, to measure the impact of IM usage on employee performance and to consider the temporal evaluation of IM usage on employee performance, we also developed models to evaluate the impact of retrospective employee performances on employee performance for the next month. To be able to do so, the following linear regression model was developed and tested (fixed and pooled models were also tested); however, the results were not significant:

$$employee\ pormance_{it} = \alpha_0 + \alpha_1 social\ networking_{it} + \alpha_3 team\ communication_{it}$$
$$+ \alpha_4 \text{knowledge sharing}_{it} + \alpha_4 \text{work interruption}_{it} + employee\ pormance_{it-1}$$
$$+ employee\ pormance_{it-2} + \gamma Z_i + \mu_i + \varepsilon_{it}$$

Discussion and Conclusion

Identifying and quantifying the organizational benefits and harms of instant messaging (IM) usage at the workplace is challenging, so adopting IM technologies remains controversial with the lack of clear cost-to-benefit analyses. Moreover, the impact of IM usage at the workplace on employee performance has never been assessed using any other methods than surveys or experimental designs. As a result the literature is

currently providing contradicting results. To the best of our knowledge, this commentary is the first to identify the core purposes of IM utilization in the workplace and measure the impact of those primary elements on employee's performance using text-mining techniques. The key to revealing the effects of instant messaging at the workplace remains in how and where employees use the technology.

According to the results, the role of IM usage in employees' daily communication and knowledge-sharing activities is indisputable. Employees can reach out to other colleges and their managers. Also, they can request and share knowledge and expertise in a way that was not possible in traditional face-to-face communication, at least not at the scale, cost-efficient and effective way that is possible in today's IM platforms. Even though the results show that IM usage at workplace can be interruptive, its negative impact on employee performance is not that significant ($\beta = -0.452$, $p < .1$), i.e., the positive impact of IM messages on both employee communication and knowledge sharing experience have more significant impact on employee performance rather than being interruptive or lowering employee performance.

Moreover, according to the result, IM usage at the workplace can significantly increase knowledge-sharing activities, and these practices of knowledge-sharing among employees can empower their performance. Knowledge-sharing is one of the elements in the knowledge management practice and is nothing but exchanging knowledge in a format of procedures, processes, ideas, methods, and mental models, essential for any decision-making process, accomplishing a personal or team task, and achieving any personal or organizational goals. We also call for organizations to adopt IM technologies to accelerate building better work and network relationships among employees and help them address common knowledge-sharing problems. We also call IM technology providers for adding features that can facilitate employees in managing documents, storing data, accessing shared information, and enabling these platforms with options that make dissemination, exchange, and sharing of information more feasible and accessible.

Besides, IM usage at the workplace is positively correlated with employees' social networking activity; however, based on our exploratory analysis, about 3% of employees' IM conversation usage was for social networking purposes. Although employees may prefer face-to-face interaction rather than using IM platforms for social networking activities, we call for IM companies and their technology providers to research and develop new features to increase social networking experiences on such platforms. It is vital to understand that multi-purpose tools like IM are becoming an inseparable and practical part of any organization, and it is necessary to improve social networking experiences among employees while using the apps, specifically during extreme situations where face-to-face interaction is not possible (like COVID 19) and social networking norms are changing. As IM technologies are also recognized as social networking tools in organizations, they may present enormous potential for improving organizational performance and employee engagement, especially in remote and distributed work environments and large enterprises.

Online communication technologies are being introduced to improve employee communication, working efficiency, and personal and organizational productivity, but the benefits aren't guaranteed. Adopting IM technology in the organization won't improve individual or organizational performance or bring significant benefits. Adopting new technologies must address an organization's problems or opportunities. IM can help organizations improve team communication, knowledge-sharing, and social networking, which can improve personal and organizational goals and performance.

Limitations and Future Research

Our research has limitations that require more study. For instance, the findings be validated against a larger sample of employees from different industries to gain more insights. Even though we worked with a unique dataset, we hope more companies from different markets (and countries) make similar datasets available to industry and academia. Having access to a dataset with more control variables like age, education, etc., could improve the statistical identification. This study did not examine the interdependencies between employees' retrospective performance and IM adoption at work. Future studies should determine if past IM adoption and performance predict future adoption and performance. Moreover, as we also presented in this paper, although IM usage at the workplace can enhance team communication, social networking, and collaboration among employees, another study can focus thoroughly on the detrimental effect of IM-related interruptions on employees' mental overload, stress, and annoyance using media synchronization theory.

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Appendix A: Coding process

We followed the content-coding steps suggested by Krippendorf (1980) and Landis and Koch (1977). One of the authors and three Master's students were part of the coding process to code the IM coding separately. Three meetings were held to understand the research project scope on IM's role in employee performance to build a coding book. Neither hypotheses nor research questions, and measurement models are shared with individuals who were in charge of coding, and they are asked not to communicate with each other during the coding process. We also performed pilot data coding in three rounds for the data set. Our primary goal was to replicate the coding process and improve the coding book until independent coding results achieved the kappa value greater than .70. The kappa value indicates the degree (percentage) of agreement among coders, which is substantially higher (>.7) than what can be achieved by chance (Krippendorf 1980; Landis and Koch1977).

Variable	Definition	Data Type
TC	A conversation expresses regular team communication. **Examples** 1. "Are we going to have a meeting at 11am EST?" (coded as "1") for team communication 2. "Would you please reply to my email?" (coded as "1") for team communication 3. "Please tell me about the meeting you had with the vendor. Was it fruitful?" (coded as "1" for team communication)	Binary
KS	An instant message that expresses any knowledge-sharing activity between users. A conversation that expresses that the given information conveys the process of transferring information from one employee to another can be tacit (undocumented) and explicit (documented). **Examples** 1. "Would you please share the document for a clean installation of the product?" (coded as "1" for knowledge sharing) 2. "The white paper I'm sharing with answer all questions you have regarding the architecture ?" (coded as "1") for knowledge sharing 3. "here is the link for the latest deck we have prepared so far" (coded as "1" for knowledge sharing)	Binary
SN	An instant message expresses any degree of social contacts, relationships, network ties, and associations by making connections through individuals. **Examples** 1. "Hey Mark, it was nice seeing you today at the expo?" (coded as "1" for social networking) 2. "it's 2 pm, lets go for a coffee" (coded as "1") for knowledge sharing 3. "will you be in the office tomorrow? if so, let's grab a bite man. Been a while" (coded as "1" for social networking)	Binary
WI	An instant message expresses any degree of interruption and may interrupt an employee's ongoing tasks. **Examples** 1. "At the middle of something, can I catch you later?" (coded as "1" for work interruption) 2. "Sorry, I'm in a team meeting now. Please reschedule" (coded as "1") for work interruption 3. "I need to finish this report by the end of the day. Talk to you later" (coded as "1" for work interruption)	Binary
TC: Team Communication, KS: Knowledge Sharing, SN: Social Networking, WI: Work Interruption		

Table A1. Coding Scheme

Appendix B: Impact of the IM Usage on IVs

Following linear regression models developed to measure the effect of IM usage at the workplace on each of the categories: team communication, knowledge sharing, social networking, and work interruption within separate equations:

$$Team\ communication_{it} = \alpha_0 + \alpha_1 IM\ usage_{it} + \gamma Z_i + \mu_i + \varepsilon_{it} \quad \text{(B.4)}$$

$$Knowldge\ sharing_{it} = \alpha_0 + \alpha_1 IM\ usage_{it} + \gamma Z_i + \mu_i + \varepsilon_{it} \quad \text{(B.5)}$$

$$Social\ networking_{it} = \alpha_0 + \alpha_1\ IM\ usage_{it} + \gamma Z_i + \mu_i + \varepsilon_{it} \quad \text{(B.6)}$$

$$Work\ interruption_{it} = \alpha_0 + \alpha_1\ IM\ usage_{it} + \gamma Z_i + \mu_i + \varepsilon_{it} \quad \text{(B.7)}$$

where Z_i represents a set of time-invariant control variables (such as gender and location), and μ_i and ε_{it} are both error terms.